INTELLIGENCE &
INTELLIGENCE TESTS

R. KNIGHT

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BY

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WITH TWO DIAGRAMS

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PREFACE TO THE SECOND EDITION

MANY people besides psychologists are interested in intelligence and intelligence tests, and it is for them that this little book is intended. The subject is of special importance to students of Psychology, teachers, school medical officers and clinic workers, but this account is not addressed to them alone. It was written for all members of the general public who are interested in the nature and assessment of intelligence.

Since this book was first published there has been no ubstantial change in the theory of intelligence or in the rinciples on which intelligence tests should be constructed. Consequently, there has been no need for any radical alteration in the text. It is true that Burt, Terman, Thurstone and Thomson, who, with Spearman, orm an unrivalled quintuplet in this branch of psychoogy, have all recently published new books, which are masterly in their depth and scope. But each of them as continued to move along the lines that he had laid own before I originally prepared this monograph, and ll that I have had to do in this edition is to bring my eferences up to date.

What has been most noticeable during the intervening ears is the growing appreciation of the value of intelligence in all departments of life, and the rapid extension f the use of tests of intelligence and of other mental qualities. Such tests are now being widely used in educational guidance and selection. Most Local Education Authorities include a test of intelligence as one of the elements in their procedure for assessing the suitability of boys and girls for different types of education. Intelligence tests are also playing an important part in the allocation of men and women to the duties for which they are best fitted in the Services. The War

Office, for example, has established a Directorate for the Selection of Personnel, which is staffed by psychologists, and every man who enters the Army, and every girl who goes into the A.T.S., is given an intelligence test as well as tests of special abilities, attainments and temperamental traits. Nor are similar arrangements lacking in the Navy or the Air Force, or the Civil Service.

Numerous references to books and articles are given in footnotes at appropriate places in the text. Three of the books may be specially mentioned here: Spearman's *Abilities of Man*, whose importance is fundamental; Macrae's *Talents and Temperaments*, to which I was much indebted in writing the earlier part of Chapter V; and Vernon's *Measurement of Abilities*, which is recommended for further reading, particularly by those who are interested in the statistical techniques that mental measurement involves.

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THE UNIVERSITY,
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CHAPTER I

INTRODUCTORY

'The simple mind and manly air,
  Not Brains so much as Breeding,
With *joie de vivre* and *savoir faire*,
  Are constantly succeeding.'

A. P. HERBERT: *The Englishman.*

IT has often been observed that, while in France intelligence is an object of admiration and delight, in Great Britain it is apt to be suspected and dispraised. The attitude of the French is said to be shown by their pleasure in discussions, their insistence on precision and clarity of expression, and their extreme sensitiveness to the adjectives *stupide* and *ridicule.* Our different attitude is revealed by our emphasis on character and conduct, our marked preference for the clean heart to the clear head, our preoccupation with the useful and the moral, and our depreciatory use of the words 'clever' 'intellectual', and 'highbrow'. Clearly, we do not value intelligence for its own sake; we regard 'mere' thinking as a distraction from practical activity, and even as a danger to our cherished convictions. 'The Englishman,' says Madariaga, who knows us, 'mistrusts thought.'[1]

Nowhere is our emphasis on doing rather than thinking more evident than in the public pronouncements of some of our distinguished countrymen. Some years ago a bank manager of high standing informed *The Times*[2] that 'the wonderful old gentlemen' who were at the head of the private banks owed their whole success to their 'undoubted character', and to the fact that they 'came from good families', and conducted their business 'with the greatest possible dignity'. In his view, these exemplars were in no way handicapped, but were actually aided, by having had 'no special training', and by having never acquired more than 'a very little technical knowledge'.

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[1] *Englishmen, Frenchmen, Spaniards,* p. 116.

[2] December, 24th, 1932.

About the same time a large number of eminent business men were invited to express their views on the qualities that make for success in commerce. With only one or two exceptions, they all tended to disparage special training, to make only a casual reference to the need for ability, and to bring into special prominence those qualities of character extolled by Samuel Smiles. It is true that these opinions were suitably described as 'scarcely more illuminating than the remarks commonly made by centenarians when invited to explain the secret of longevity';[1] but they nevertheless reflect the English tendency to rate action and character above intelligence.

Mr. F. L. Lucas believes that 'the English instinct to rely on instinct' comes out clearly in our attitude to all training and education: 'We still value', he says, 'for the flower of our youth the playing-fields above the laboratories of Eton; for the flower of our army, Chelsea barrack-square above aeroplane and tank.'[2] And certainly the utterances of some of our elder statesmen and head masters, especially on speech-days and other such occasions, seem to support his view, for in them the value of the intellect is often minimized, and the value of character, and of the activities that are held to form it, is given first importance. Our itch for sitting in moral rather than intellectual judgment is also exhibited by our panegyrics and obituary notices in which we formally record the great man's abilities and achievements, but lavish praise on his kindness, his amiability, his modesty, his unfailing generosity, and his staunchness to his friends.

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[1] Macrae, *Talents and Temperaments*, p. 148.

[2] *Life and Letters*, Vol. VII, p. 9.

There are signs, however, that our belittling of intelligence is decreasing. Before the advance of modern science, which is so conspicuous in modern war, it seems a little out of date, and some people are asking uneasily whether the lives of both individuals and communities would not be improved, and their safety more effectively secured, by a greater reliance on controlled and directed thought. For example, a distinguished Fellow of All Souls, regarding Lord Elton's recent praises of character as excessive, writes: 'As if we didn't hear about character *ad nauseam* in English education already, when what the nation needs is to set more store by intelligence and clear thinking.'[1] No doubt we have not yet come to regard intelligence as something delightful in itself; the frank passion for the intellect which is said to be characteristic of the French does not flourish among us; our prevailing attitude is still one of distrust. But we are at any rate beginning to realize that intelligence is a useful means of getting work done—a necessary and serviceable instrument for furthering our practical desires, in war as well as peace.

Economists speak of results to be achieved by 'deliberate, conscious control'. Even in business there is a small but growing group of men who believe that trading is a calculable, not an incalculable, affair, where rigorous, constructive thinking is indispensable. These men, of course, do not decry courage, or energy or conscientiousness; they realize that these and other qualities of character retain their immense and undisputed value. But they do point out that courage and energy are never more successful than when guided by calm and penetrating foresight; and, as regards conscientiousness, they suggest that even the most active conscience needs to be enlightened. In their eyes, too, the old buccaneering 'captain of industry', who relied solely on a masterful manner, a magnetic personality, and blunt common sense, is almost a figure of fun. They know that to-day the successful business man is often neither domineering nor magnetic, that he must work hard at solving problems, and that one of the main requirements is trained ability.

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[1] Rowse, *The New Statesman and Nation*, May 23rd, 1942.

The same change of attitude—a decreasing depreciation of intelligence—may also be discerned in many other aspects of our life. In present-day education, for example, the adjectives 'conceited' and 'priggish' are not inevitably applied to the boy that excels mentally; in some instances, indeed, he even receives moderate approbation, which brings him at least within measurable distance of the boy that excels at games. And teachers, though they still clap loudest when they are exhorted not to neglect the training of character, are increasingly alive to the fact that they should also detect, release, and develop their pupils' abilities.

For these reasons and others, employers, managers, and teachers, as well as the military authorities, are paying much more attention to intelligence, and to its measurement, than they did. Moreover, if we may judge from the publicity that modern intelligence tests have acquired, there is little indifference to the subject even among people for whom it has no special, professional importance. Parents, in particular, realizing that in their own children, as in all human beings, intelligence is important as well as good manners and intentions, evince a growing interest in the nature and assessment of mental capacity.

In the later part of this book we shall deal with intelligence tests—with the ways in which they are constructed and verified, and with the purposes for which they are being profitably employed. But first we shall deal with the nature of intelligence itself—a matter about which there is divergence of opinion. It may seem strange that it should be possible to measure, even approximately, something whose fundamental nature is differently defined by different people. But there is no real inconsistency here—any more than there is inconsistency in the fact that electricians can measure the strength of an electric current when they are unable to define electricity. Indeed, some psychologists would hold that analysis and definition of such basic concepts as intelligence are outside the province of psychology, whose function is confined to the description and measurement of mental phenomena and the discovery of regular sequences and correlations among them. With this view, however, we are not in agreement. For the practical purpose of measuring intelligence, it may well be that full knowledge of its nature is unnecessary. Terman is no doubt right when he says that 'to demand that one who would measure intelligence should first present a complete definition of it is quite unreasonable'.[1] But science does not exist to serve practical purposes alone, and study of the nature of intelligence is an important part of the science of psychology, just as study of the nature of electricity—though possibly of little practical value to engineers—is an important part of the science of physics.

But before we set forth what the psychologist has discovered about the nature and measurement of intelligence, one further preliminary remark needs to be made. Readers of this book will have observed that, unfortunately, intelligence is one of those topics that many people regard with some degree of fear and consequent prejudice. Even those who depreciate the intellect usually want to be—or at least to be thought to be—more intelligent than they really are. They do not welcome the suggestion that intelligence can be defined, and that their own intellectual capacity can be assessed and compared with that of other people. They therefore tend to place intelligence under a taboo, to discourage its systematic study, and to decry any attempt to devise instruments by which an individual's intelligence may be measured. They seek to preserve their complacency by condemning what they think may undermine it.

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[1] *The Measurement of Intelligence*, p. 44.

The same holds good for character. There, too, we find stern opposition to any view that appears to underrate the worthiness of human nature. It seems that, at all costs, people must retain their self-esteem. If, for example, any one invented, and offered for sale, a cheap appliance, which could infallibly detect deceitfulness and other unamiable traits, he would probably be the victim first of ridicule and then of angry abuse; and vigorous attempts to prevent the use of his apparatus would undoubtedly be made.

This book, however, deals exclusively with intelligence, and we are not at present concerned with the prejudice that unflattering theories of character normally excite. It is in regard only to the intellect that an open mind is needed here; and, of course, in making this remark in this context, we are probably preaching to the converted.

CHAPTER II

THE TWO-FACTOR THEORY

> 'The frank adoption of Two Factors would seem to supply an adequate basis—the only one possible—for a unified science of all human ability.'—C. SPEARMAN: *The Abilities of Man.*

IN considering the nature of intelligence, we come at once to Spearman's discovery that there is a common element in all our cognitive abilities. This discovery, which illuminates the whole problem of intelligence, is part of his famous two-factor theory—the theory that every different intellectual activity involves a general factor, which it shares with all other intellectual activities, and a specific factor, which it shares with none.

This two-factor theory, which rests on experimental observations and mathematical reasoning, was first put forward in 1904, nearly forty years ago. Spearman then expressed it in the statement that 'all branches of intellectual activity have in common one fundamental function (or group of functions), whereas the remaining or specific elements seem in every case to be wholly different from that in all the others'.[1] And at that early stage of his researches he expressly pointed out that 'it must acquire a much vaster corroborative basis before we can accept it even as a general principle and apart from its inevitable corrections and limitations'.[2] For a long time, while this 'much vaster corroborative basis' was energetically being sought, the theory was made public only in a very fragmentary manner, and erroneous interpretations were not uncommon. In 1927, however, it was clearly and admirably expounded in *The Abilities of Man*; and in that book Spearman declared that 'it has never from the very beginning undergone any substantial change whatever: only a continual development of more detail; in particular, an unceasing increase of exactitude and cogency'.[1]

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[1] *American Journal of Psychology*, Vol. XV, p. 284.

[2] Ibid.

Spearman's conclusions about cognitive abilities are derived from his discovery that these abilities are correlated with each other in a special way. Accordingly, to understand his evidence and argument, we must first understand the concept of correlation.

We begin with the fact that between variations in one thing and variations in any other there must be some positive or negative relationship, or no significant relationship at all. Between variations in temperature and variations in the height of a column of mercury in a thermometer there is a positive relationship, since increases in the one are paralleled by increases in the other, and decreases by decreases. Between variations in the amount of sand in one bulb of an hour-glass and variations in the amount of sand in the other bulb there is a negative relationship, since increases in the one are paralleled by decreases in the other, and decreases by increases. And between variations in the length of eyebrows and variations in kind-heartedness there is probably no significant relationship, either positive or negative.

Statisticians use the term 'correlation' to cover all these different ways in which variations in one thing may be related to variations in another. They speak of 'positive correlation', of 'negative correlation', and of 'absence of correlation'. And they recognize that, whether positive or negative, correlation varies in degree. While there is positive correlation, for example, both between temperature and thermometer-readings and between the height and the weight of a representative sample of human beings, it is higher in the first case than in the second.

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[1] Op. cit., p. 83.

Statisticians have also devised a number of methods by which the degree of correlation between two variables may be determined. The usual method is one that results in expressing the degree of correlation by a coefficient, which varies from 1 down to 0, according as the correlation varies from perfect positive dependence to perfect independence, and from 0 to -1, according as the correlation varies from perfect independence to perfect negative dependence. Thus the coefficient of correlation between temperature and thermometer-readings is 1; that between the height and weight of a representative sample of human beings is positive but less than 1; that between length of eyebrows and kind-heartedness is probably insignificant; and that between the amount of sand in one bulb of an hour-glass and the amount of sand in the other bulb is -1. The coefficient of correlation is symbolized by the letter r; and, usually, the coefficient of correlation between two variables, a and b, is expressed as r_{ab}. With this general knowledge of what is meant by correlation, and by the coefficient of correlation, we may now turn to the experimental data that have led to the two-factor theory.

Spearman began by discovering that when he examined measurements of any cognitive abilities—abilities that have to do with the thinking or intellectual aspect of the mind, and not with feeling or desiring—and calculated their coefficients of correlation, these coefficients tended towards a peculiar and orderly arrangement. This arrangement is expressed in the following formula, where *a*, *b*, *c*, and *d* denote *any* four of the measured abilities:

$$(r_{ab} \times r_{cd}) - (r_{ad} \times r_{bc}) = 0$$

This formula is called the 'tetrad equation', and the value of its left side the 'tetrad difference'.

For the sake of illustrating what is meant by the tetrad equation, let us suppose that we have measured five cognitive abilities: the ability to draw inferences, the ability to complete sentences, the ability to continue series of numbers, the ability to supply synonyms of given words, and the ability to code messages. Let us suppose, further, that we have calculated the coefficient of correlation between every one of the five abilities and each of the other four, and that these coefficients are as follows:

	Inferences	Sentences	Numbers	Synonyms	Codes
Inferences .	—	·42	·35	·28	·21
Sentences .	·42	—	·30	·24	·18
Numbers .	·35	·30	—	·20	·15
Synonyms .	·28	·24	·20	—	·12
Codes . .	·21	·18	·15	·12	—

This table of coefficients satisfies the tetrad equation. If we take *any* four of the abilities, and name them *a*, *b*, *c*, and *d*, we find that $(r_{ab} \times r_{cd}) - (r_{ad} \times r_{bc}) = 0$. For example, let *a* denote the ability to code messages, *b* the ability to complete sentences, *c* the ability to draw inferences, and *d* the ability to continue series of numbers. Then the tetrad equation becomes

$$(\cdot 18 \times \cdot 35) - (\cdot 15 \times \cdot 42) = 0$$

Similarly, let *a* denote the ability to supply synonyms, *b* the ability to continue series of numbers, *c* the ability to draw inferences, and *d* the ability to complete sentences. Then the tetrad equation becomes

$$(\cdot 20 \times \cdot 42) - (\cdot 24 \times \cdot 35) = 0$$

We have considered only two sets of four abilities; but any set of four will be found to satisfy the tetrad equation.

At the beginning, of course, Spearman had relatively few measurements of abilities. But he and his colleagues have since collected and analysed a vast number of measurements, comprising a great variety of intellectual processes. And in *The Abilities of Man*, where he reviews all this co-operative work, he sums up its results by saying that, except where 'the way of sampling, or the administration of the tests, or the procedure of marking has been vitiated by illegitimate influences', measurements of all kinds of cognitive abilities satisfy the tetrad equation.[1]

So much for the factual basis with which Spearman's researches have provided him. In itself, and at the first blush, it may seem somewhat unexciting. Its importance lies in the conclusion which it is said to entail. By mathematical reasoning, Spearman claims to show that, since measurements of different abilities satisfy the tetrad equation, there must be in each of these abilities a general factor, which is common to them all, and a specific factor, which is confined to the particular ability in question. This, as we saw, is the two-factor theory. If Spearman be right, it necessarily follows from the application to observed correlations of a mathematical theorem, whose proof 'has gradually evolved through various stages of completeness, and may now be regarded as complete'.[1]

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[1] Op. cit., p. 159. In actual practice the tetrad equation is never found in its perfect form. This is because our coefficients of correlation, being based on the measurement of samples, are inevitably influenced by the errors of sampling, and so cannot yield a tetrad difference of precisely 0. The tetrad equation is satisfied, however, when the tetrad difference has just such a value as the errors of sampling are likely to produce.

A little reflection will show that abilities which are each divisible into two factors, general and specific, must satisfy the tetrad equation. Every such ability, since it partly depends on the general factor, is positively correlated with it to a greater or less extent; abilities that depend much on the general factor are highly correlated with it, while those that depend most on their specific factors are only slightly correlated with the general factor. Further, since any two such abilities are both correlated with the general factor, they must be correlated with each other. If, for example, the ability to draw inferences is correlated with the general factor to the extent of ·7, and the ability to complete sentences is correlated with the general factor to the extent of ·6, then the ability to draw inferences is correlated with the ability to complete sentences to the extent of ·7 × ·6, i.e. ·42. Suppose now that we have five abilities—the same five as we considered before: the ability to draw inferences, the ability to complete sentences, the ability to continue series of numbers, the ability to supply synonyms, and the ability to code messages. Suppose, further, that they are correlated with the general factor to the extent of ·7, ·6, ·5, ·4, and ·3 respectively. Then, for example, the ability to complete sentences will be correlated with the ability to supply synonyms to the extent of ·6 × ·4, i.e. ·24, and the ability to continue series of numbers will be correlated with the ability to code messages to the extent of ·5 × ·3, i.e. ·15. In short, the coefficients of the correlations of the various possible pairs will be those set out in the table on p. 10, which, as we saw, satisfies the tetrad equation.

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[1] Ibid., p. 75.

Spearman's proof of the two-factor theory moves backward from this result. He claims to have shown not only that abilities which are divisible into two factors, general and specific, necessarily satisfy the tetrad equation, but also, conversely, that abilities which satisfy the tetrad equation are necessarily divisible into the two said factors.

For us, the important feature of the two-factor theory is its statement that a general factor enters into all our cognitive abilities and underlies all our thinking. This general factor is important because we can identify it with intelligence. Spearman himself names it *g*. He thinks that the word 'intelligence' has become 'a mere vocal sound, a word with so many meanings that finally it has none',[1] and he tries to avoid its use. Still, he does explicitly identify *g* with intelligence in more than one passage, and, as we shall see, this identification is fully justified.

Here, however, we should note that the two-factor theory has not been everywhere accepted. In the United States, for example, it was long attacked by Thorndike, whose early investigations led him to the view that the mind is 'a host of highly particularized and independent faculties'.[2] But Thorndike later changed his position. In *The Measurement of Intelligence*, published in 1927, he abandoned his former view, and searched for a 'unitary fact'—or general factor—underlying our various intellectual abilities.[3]

In Britain, Spearman's most active critic has been Thomson.[4] He admits that abilities which are each divisible into two factors, one general and the other specific, must satisfy the tetrad equation, but denies that, conversely, abilities which satisfy the tetrad equation must each be divisible into two factors. In other words, he attacks not the observed correlations from which the two-factor theory is derived, but Spearman's inference from them. In Thomson's view, the two-factor theory, although it does account for the facts, is not the only possible explanation. The facts can also be explained by the hypothesis that there are 'group' factors, each of which is common to a limited number of different intellectual abilities, and is therefore less restricted in its range than any of Spearman's specific factors, and yet not of universal range as is Spearman's general factor.

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[1] Ibid, p. 14.

[2] *Educational Psychology*, 1903, p. 39.

[3] Cf. op. cit., p. 412.

[4] Cf. Brown and Thomson, *The Essentials of Mental Measurement*, and Thomson, *The Factorial Analysis of Human Ability*.

Thomson's criticisms, however, were directed against Spearman's first proof of the two-factor theory, not against that which was communicated to the Royal Society in 1922, and later set out in *The Abilities of Man*. And it is to be noted that not only Spearman but also such other competent judges as Garnett,[1] Brown,[2] and Irwin,[3] believe that conformity to the tetrad equation is a sufficient as well as a necessary condition of the existence of the general factor.

Moreover, a considerable measure of agreement between the disputants seems to have been achieved. Spearman still claims to have proved that each of our intellectual activities depends partly on a general factor, which underlies them all, and partly on a specific factor, which *in its entirety* is peculiar to the activity in question. But he agrees that a specific factor may contain elements that are present in some others; he admits that, in certain instances, specific factors to some extent overlap to form broader functions or 'group' factors. Thus the specific factor, the special ability, which, in addition to general intelligence, is required in learning French, *partly* consists of verbal ability, which is a group factor that enters into all mental operations involving words. Some of the specific factors, however, appear to be highly specific. Different types of imagery, for example, show little sign of depending on any second common factor—such as 'imaginative ability', which, if it existed, would be a group factor—in addition to the general factor, or intelligence, which underlies all cognitive activities of the mind.

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[1] Cf. papers quoted by Spearman, op. cit., Appendix.

[2] Cf. Brown and Stephenson, *British Journal of Psychology*, Vol. XXIII, pp. 352–70.

[3] Cf. ibid., pp. 371–81.

The most firmly established group factors appear to be (i) verbal ability; (ii) numerical ability; (iii) mechanical ability; (iv) musical ability; (v) logical ability; (vi) the capacity for sustained intellectual effort; (vii) certain forms of memory—not memory in general, but the ability to remember material of a special kind, as, for example, the ability to remember words, the ability to remember things, and the ability to remember ideas; (viii) the ability to change quickly and effectively from one mental task or train of thought to another; and (ix) the different group factors that enter into the different types of school work—literary, scientific and manual.[1]

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[1] Cf. Vernon, *The Measurement of Abilities*, pp. 166-9, and Burt, *The Factors of the Mind*.

CHAPTER III

THE NATURE OF INTELLIGENCE

> 'While the teacher tried to cultivate intelligence, and the psychologist tried to measure intelligence, nobody seemed to know precisely what intelligence was.'—P. B. BALLARD: *Mental Tests.*

SPEARMAN may therefore be regarded as having shown that intelligence enters into all our cognitive abilities. And this is a most important discovery, in the light of which, as Burt has said, 'the whole basis of our intellectual life becomes far easier to analyse'.[1] But the question still remains: How is intelligence to be defined?

THE DEFINITION OF INTELLIGENCE

03 We suggest that intelligence is the ability, when we have some aim or question in mind, (*a*) to discover the relevant qualities and relations of the objects or ideas that are before us, and (*b*) to evoke other relevant ideas. In other words, it is the capacity for relational, constructive thinking, directed to the attainment of some end. The man of high intelligence is one who, faced with a problem, can seize upon the significant aspects of the objects or ideas before him, and can bring to mind other ideas that are relevant.

It will make the meaning of this definition clearer if we consider three concrete examples—three simple tasks which would be universally admitted to involve intelligence, and which are, in fact, of the type commonly used in intelligence tests:

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[1] *Philosophy*, Vol. II, p. 560.

(i) A child is asked to say in what way a snake, a cow and a sparrow (or a book, a teacher and a newspaper) are alike. Clearly he must consider the qualities of the three things and discern one that they all possess. Only the common qualities are 'significant'; the ways in which the three things differ are beside the point—it is to the relation of similarity between them that the child must direct his mind. Success lies in selecting and attending to the qualities and relations that are relevant to the question asked. It requires the first of the two abilities that enter into intelligence.

(ii) A child is given an 'opposites' test, in which he is provided with a list of words and asked to supply their opposites. Here what is required is, not the ability to discover relevant relations between given items of knowledge, but the ability, when given a particular item (e.g. black) and a particular relation (oppositeness), to think of that item which is related to the given item by the given relation. This process, known as the 'eduction of correlates', involves the second of the two abilities that are included in our definition of intelligence.

(iii) A child is asked what is related to blood as white is related to snow. He must first discern the relation between white and snow and then determine what is related to blood by this relation. In this instance both the ability to discover relations and the ability to educe correlates are required.

We have taken simple examples. But the same principles apply to more complicated cases. However simple or difficult a task may be, its solution, in so far as it involves intelligence, entails, we suggest, either or both of the abilities that our definition embraces. The intelligent government of a nation, the intelligent management of a large business organization, the intelligent carrying out of scientific research, the intelligent study of literature or life, the intelligent running of a house, and the intelligent building of a rabbit-hutch—all these activities, in requiring intelligence, require directed, relational, constructive thinking. In every case intelligence consists, as we have said, in the ability to discover the significant aspects of what is before our mind, or in the ability to educe relevant correlates, or in a combination of both these abilities.

Our definition of intelligence, then, is one that results from an examination of examples of intelligent activity. But this is not the only ground for its acceptance. It is also strongly supported by the researches of Spearman. The two-factor theory, as we saw, holds that each of our cognitive abilities involves, first, a general factor, which is common to all our abilities, and, secondly, a specific factor, which, taken as a whole, is confined to the particular ability in question. It also holds that, although both factors enter into every cognitive ability, their relative influence—which can be measured—is not always the same. In some abilities, like the talent for classics, the general factor has a much greater influence or 'weight' than it has in such other abilities as the talent for music. Now, Spearman has shown that a task involves the general factor, or intelligence, in proportion as it involves the discovery of relations and the eduction of correlates. And this finding provides an additional reason for analysing intelligence in the way we have done.

Spearman himself believes that intelligence comprises three abilities: (i) The ability to observe one's own mental processes; (ii) the ability to discover essential relations between items of knowledge, whether perceived or thought of; and (iii) the ability to educe correlates. In our view, however, the first of Spearman's three abilities is merely a special form of the second. Intelligently to observe one's own mental processes is to discern their significant qualities and relations; it requires nothing more than the application of the second ability (modified to include qualities as well as relations) to facts discerned by introspection. Accordingly we see no reason for its separate mention. And, in fairness to Spearman, it should be said that he himself in one place declares that 'the two non-experiential principles [i.e. the second and third of the three abilities mentioned above] most conspicuously deserve the name of intelligence'; in the same place he says that the first ability—the ability to observe one's own experiences—'has the least obvious claims to the name'.[1] Moreover, in *Creative Mind* he so defines the first ability as to suggest that it is less concerned with the observation of mental experiences than with the observation of what is experienced. In other words, it becomes the ability to discern the relevant qualities of what we perceive or otherwise cognize, and is clearly a part of the first of the two abilities which, in our view, constitute intelligence.[2]

Our definition, besides confining itself to the discovery of qualities and relations and the eduction of correlates, also differs from Spearman's in another respect. It emphasizes the fact that the qualities and relations discovered, and the correlates educed, must be relevant to some question or aim. In this matter we agree with Wyatt. 'The difference', he says, 'between the unintelligent and the intelligent individual is just that between two individuals, with equal intentness on the same end, and equal experience, of whom one can assemble the parts of an automobile so as to fit them into a whole machine and the other keeps bungling and fitting the wrong parts together. One apprehends the relevant relations, the other does not. He apprehends all sorts of relations which are relations no doubt but are not relevant.'[1] The same fact has been expressed by Mace in dealing, in *The Psychology of Study*, with 'efficient observation', or intelligent perception. He points out that one of the main requirements of such perception is 'selectivity', or the power of noticing just what is pertinent to the particular question or purpose one has in mind. 'The hallmark of an inspired observation,' he says, 'is its relevance.'[2]

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[1] *The Nature of Intelligence*, p. 352.

[2] Cf. *Creative Mind*, pp. 15–18.

2) It is noteworthy that intelligence is not confined to what is sometimes called 'pure' thought. We can exhibit intelligence, not only in puzzling out the answers to elaborate abstract teasers, but also in solving a jig-saw puzzle, in searching for the cause of a breakdown in our motor-car, in burgling a house, or in other practical problems. We can observe intelligently as well as reason intelligently. We can grasp significant qualities and relations among perceived objects; and such objects, no less than images or ideas, can cause us to educe relevant correlates. This fact has been clearly brought out by Spearman, who has shown that the general factor enters into perceptual tasks as well as into those that involve abstraction and reasoning.

Again, there is obviously room for intelligence in our understanding and handling of people, as well as in our understanding and handling of physical things. Here, as elsewhere, differences in intelligence are differences in the capacity for relational thinking. The person with no understanding of human thought and behaviour, like the person with no understanding of the external world, is one who neither compares his observations with one another nor finds that they evoke fresh ideas in his mind.

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[1] *The Psychology of Intelligence and Will*, p. 88.

[2] Op. cit., p. 26.

২) The absence of retentiveness from our definition of intelligence may cause some surprise, for Woodworth[1] and some other psychologists have held that it is an essential feature of intellect. This exclusion is intentional. Intelligence, of course, is involved in memory in so far as memory comprises the ability to assimilate material and the ability to reproduce relevant parts of it. And intelligence itself involves so much memory as is involved in holding ideas before the mind while one discovers their relevant relations and educes their relevant correlates. Still, it has no further connexion with the mere ability to retain what has been assimilated—an ability that mental defectives sometimes exhibit to a high degree. In Spearman's investigations, intelligence 'revealed a surprisingly complete independence of all manifestations of retentivity'.[2]

OTHER ACCOUNTS OF INTELLIGENCE

We have said that our definition resembles Spearman's. Another which it resembles is that of Wyatt. He, however, restricts intelligence to the power of apprehending relevant relations.[3] He leaves out the eduction of correlates deliberately, on the ground that 'the appearance in consciousness of the correlate depends upon and is conditioned by the power of apprehending relations'.[4] But, clearly, this is an

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[1] Cf. *Psychology*, p. 286 in the first edition; in his last (twelfth) edition, Woodworth no longer advocates this view.

[2] *The Abilities of Man*, p. 412.

[3] Cf. op. cit., Chaps. V, VII.

[4] Ibid., p. 84.

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inadequate reason for excluding the eduction of correlates from the analysis of intelligence. No doubt the power to educe correlates does depend upon the power to grasp relations, but it is none the less a different power, which must be separately stated.

According to Terman,[1] 'an individual is intelligent in proportion as he is able to carry on abstract thinking'. But there are at least four objections to the description of intelligence as the power of abstract thought. In the first place, it implies that intelligence cannot be manifested at the level of perception, whereas in fact intelligence is, as we said, clearly involved in perceptual tasks. In the Healy picture-completion test, for example, the candidate is given a picture in which a hole has been cut, together with several insets any of which will fill up the hole; he has to choose that inset which best completes the sense of the picture —that which is most appropriate to the subject depicted. Intelligence is required here, but not at the level of abstract thought. It is true that abstract tasks (the supplying of synonyms, opposites, or analogies; the completion or disentangling of sentences; the drawing of inferences, etc.) depend more on intelligence than do perceptual tasks (the completion of pictures, the discrimination and comparison of forms, etc.).[2] Nevertheless, intelligence enters into perception.

A second objection to Terman's definition is that it does not state that, in order to exhibit intelligence, the abstract thinking must be relevant to some question or aim. It ignores the fact that undirected abstruse thought is as little intelligent as undirected observation, and is nowhere more prevalent than in lunatic asylums.

Thirdly, the statement is insufficiently analytic. It assumes that the capacity for abstract thinking is simple and indivisible, whereas, in fact, it is a compound ability comprising more than one power.

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[1] *Journal of Educational Psychology*, Vol. XII, p. 128.

[2] Cf. Stockton: *Psychological Monographs*, Vol. XXX, No. 137

Fourthly, the capacity for abstract thought, like all other abilities, involves factors specific to itself as well as intelligence, and therefore to identify it with intelligence is a mistake.

9) Thorndike provides us with a different definition. He believes, as we shall see, that 'in the last analysis', intelligence must be defined in terms of physiology. Still, he does also put forward a corresponding psychological definition, holding that intelligence consists in the capacity for 'mere association or connection-forming';[1] and that individuals differ in intelligence by differing in the number of associations of ideas that their minds can make.

This surprising view is based on investigations carried out by Thorndike and Tilton. Tests of 'intellectual' abilities, and tests that purported to require 'purely associative' ability, were given to nearly 500 persons. The results of these tests showed that what was common to the 'intellectual' abilities was highly and positively correlated ($r = \cdot 94$) with what was common to those other abilities which, in Thorndike's view, were 'purely associative'.

'These facts', says Thorndike, 'are almost crucial. They prove that mere association and the higher abilities have in the main the same cause. Almost all of whatever is common to the one sort is common to the other sort. If we are to avoid the conclusion that associative ability is this cause, we must either place the causation of associative ability in the higher ability, or seek a common cause for both which is different from either. . . . The first of these assumptions is absurd. . . . The second assumption is tolerable, though it seems defensive and evasive.'[1] In other words, Thorndike argues that the correlation that his investigations revealed cannot be adequately explained except on the hypothesis that the essential element in intelligence is the capacity for 'mere association'.

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[1] *The Measurement of Intelligence*, p. 415. Cf. Chap. XV *passim.*

The validity of Thorndike's argument obviously depends on the truth of his claim that mere association is highly and positively correlated with intelligence. His investigations do establish a high positive correlation between the abilities measured by his two sets of tests. But it is extremely doubtful whether those of his tests that purported to involve 'purely associative' ability really involved nothing else. They include arithmetic tests, vocabulary tests, and tests of general knowledge. Typical examples are: to divide 50 by 7; to find the cube root of 64; to calculate 5.25 per cent of 200 dollars; to say how many centimetres there are in an inch; and to say whether vinegar is made from picric acid, or apples, or bark, or lemons. Surely it is not 'pure' association that these tests require. They seem to need a low degree of just that 'selective and relational thinking' which Thorndike's tests of 'intellectual' ability were designed to measure.

We suggest, then, that, since the so-called 'associative' abilities were not merely associative, it is not 'absurd', as he claims, to infer that the cause of the observed correlation is in the higher abilities. There is good reason to believe that the correlation between the two sets of tests was due to the fact that both involved relational thinking. In other words, what Thorndike revealed was, not a correlation between intelligence and 'mere' association, but a correlation between two manifestations of intelligence.

But the most convincing evidence that there is a fallacy in Thorndike's argument is to be found in the evident falsity of its conclusion. If Thorndike were right, and intelligence were the capacity for mere association, then many mental defectives, whose associations are often numerous, would have average or superior intelligence. The truth is, however, that d) Thorndike is not consistent. Thus, while claiming that intelligence is the capacity for 'mere association or connexion-forming', he also says that 'there is no doubt that the appreciation and management of relations is a very important feature of intellect, by any reasonable definition thereof'.[1] Moreover, in the very chapter where he claims to demonstrate that 'quality of intellect depends upon quantity or connexions',[2] he seeks to draw a sharp distinction between associative abilities and 'the "higher" abilities of selective and relational thinking, abstraction, generalization, and organization'.[3] Indeed, there are many passages in which Thorndike seems to hold that intelligence is the capacity, not for mere association, but for controlled association. And in so doing, he expresses, of course, the same view of intelligence as we have suggested. For, when he distinguishes associations that are undirected and senseless from those that are directed and sensible—when, in other words, he distinguishes between free association and association that is guided by considerations of relevance—then he is regarding intelligence as the capacity for relational thinking.[4]

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[1] Op. cit., p. 430.

h) Another definition is put forward by Thurstone.

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[1] Op. cit., p. 19.

[2] Ibid., p. 415.

[3] Ibid., p. 422.

[4] In general the associationists—those who sought to reduce all the reflective operations of the mind to association—regarded the more intellectual functions as involving *controlled* association, and included 'relevance' among the controls.

He believes that every example of conscious behaviour is divisible into a sequence of stages: the experience of an impulse; a search for appropriate stimuli; action in relation to these stimuli; and satisfaction of the impulse. And, according to him, 'intelligence, considered as a mental trait, is the capacity to make impulses focal at their early, unfinished stage of formation'.[1] In other words, people differ in intelligence by differing in the speed with which they become clearly aware of any impulse that is seeking satisfaction. The person who becomes fully conscious of his impulses at any early stage in the process of satisfying them is more intelligent than the person whose awareness is delayed, because the earlier the point at which the impulse is made focal, the greater the range of possible actions that may be taken to satisfy it.

But does all conscious behaviour comprise the sequence of phases set out by Thurstone? In particular, does it always originate in an inner impulse? When a bill arrives from our tailor and we send him a cheque, our action seems to spring from the external stimulus that was provided by the arrival of the bill. To be sure, in this instance as in others, no action would have occurred unless we had been disposed to ① respond to the stimulus. Nevertheless it was the external stimulus that provoked us.

Moreover, even if we agree with Thurstone that the sooner intelligence intervenes in any course of behaviour the more useful it is, does it consist in focalizing the impulse that is seeking satisfaction? Surely, if a man is thirsty and looks for a drink, there will be nothing obviously intelligent in his becoming increasingly aware of his thirst. In so far as he exhibits intelligence, it will be in his selection of the means whereby his thirst may be slaked, and this will involve just that kind of relational thinking with which we have suggested that intelligence can be identified. In short, while it is always desirable to know what end we are aiming at, intelligence consists, not merely in being aware of the end, but in critically appraising it, and in choosing the best way of reaching it.

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[1] *The Nature of Intelligence*, p. 159.

1) Here we may appropriately refer to Binet, who held that intelligence involves: (i) The tendency to take and maintain a definite direction; (ii) the capacity to make adaptations for the purpose of attaining a desired end; and (iii) the power of self-criticism.[1]

Our only comment on the inclusion of the second and third of these abilities in intelligence is that, although both of them involve intelligence, they each involve other and specific factors as well; and, in so far as they do entail intelligence, it is just that capacity for relational thinking which our definition sets forth. 'The tendency to take and maintain a definite direction', however, is on an entirely different footing. Its inclusion is simply the result of confusing intelligence with other factors that make for success in mental tasks. In the first place, it has nothing to do with the cognitive aspect of mental activity; it is a temperamental quality—a disposition of character, like irritability, fickleness, or ambition. Secondly, it is not only quite distinct from intelligence, but not even positively correlated with it. Indeed the available evidence indicates that a high degree of intelligence is often accompanied by a temperamental aversion from continuous work, by a lack of persistence and perseverance. The fact that the highly intelligent pupils in an ordinary class tend, in spite of their intelligence, to do relatively inferior work through lack of competition is a recognized reason for the institution of special classes for bright children. It is not only the dull who dissipate their energies.

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[1] *L'Année Psychologique*, 1909, pp. 128 sqq.

5) Intelligence has also been defined as the ability to solve problems, or—in the words preferred by some psychologists—as the ability to adapt oneself to new situations. But this statement is unsatisfactory. In the first place, it does not really analyse or define what is meant by intelligence. It identifies intelligence with the ability to solve problems, but it does not set forth elements into which that ability can be divided. Secondly, there is in fact no single ability which is the ability to solve all kinds of problems. The ability to solve any particular problem includes factors specific to the problem in question or restricted to the particular group of problems to which it belongs. Hence the ability to solve a mathematical problem differs from the ability to solve a problem in dressmaking, and, in general, there are as many different abilities as there are different kinds of problems. Thirdly, while intelligence does enter into all these abilities—into the ability to solve a problem in a drawing-room as well as the ability to solve a problem in yachting, or trigonometry, or physiology—it does not constitute the whole of any of them, since, as we have just said, each ability involves also elements that are specific to itself, as well as group factors that it shares with some other abilities. The ability to solve a problem in the interpretation of Molière, for example, depends on the ability to understand French as well as on the ability to think intelligently; and the ability to solve a problem in engineering is aided both by mechanical ability and by a knowledge of mechanics. In short, the ability to solve any problem, although involving intelligence, is not identical with it.[1]

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[1] These three criticisms also apply to the attempt to define intelligence as the ability to acquire knowledge, or the ability to learn.

CONCLUSION

Having now reviewed some of the principal descriptions of intelligence that have been put forward, we revert to our definition, which, as we said, is fundamentally similar to that of Spearman. In our view, intelligence must be regarded as the general factor which underlies all our thinking, and comprises the power to discover relevant relations and the power to educe relevant correlates.

CHAPTER IV

PHYSIOLOGICAL ACCOUNTS OF INTELLIGENCE

> 'If the brain is the coloured, irritable, convoluted pulp that physiologists study, then this quivering indented thing is not the mind.'—JOHN LAIRD: *A Study in Realism.*

VERY popular at present are attempts to explain, and even to analyse, intelligence in physiological terms. Many psychologists are impressed by the fact that, so far as our attested scientific knowledge goes, mind seems to be invariably associated with matter; not, indeed, with all forms of matter, but with certain physical and chemical processes in animal organisms. They are also influenced by the growing evidence of detailed interconnexion between particular functions of the human mind and particular functions of the human body. And, in the result, some of them hold that every mental activity has a physiological correlate, or cause, while others go further and assert that mental activities are themselves really physiological.

The first of these general views tends to produce, and the second necessarily produces, a physiological description of intelligence—a description that purports to employ only the concepts of physiology. Thus intelligence is defined by Bernard as non-mental 'effectiveness of adjustments',[1] and by Sandiford as 'a function of the central nervous system',[2] while Thorndike claims that 'the person whose intellect is greater or higher or better than that of another person differs from him in the last analysis in having, not a

[1] Cf. *Introduction to Social Psychology*, p. 209.

[2] *Educational Psychology*, p. 143.

new sort of physiological process, but simply a larger number of connexions of the ordinary sort'.[1]

We have said that some psychologists hold that mental activities are not merely associated, but actually identical, with physiological processes. These are the extreme 4) Behaviourists, who, in Watson's words, 'find no evidence for mental existences or mental processes of any kind'.[2] In their view, human beings, and other animals, are organisms possessing only material properties. 'Mind', 'consciousness', 'imagination', 'recollection', and 'reasoning', really stand for certain types of bodily behaviour. 'Thinking of the Tower of London' means 'behaving in such-and-such a way'; the two phrases are synonyms—two names for the same thing, as are 'big' and 'large'. It must be observed, however, that, when a Behaviourist says that all mental processes can be reduced without remainder to specific forms of bodily behaviour, he does not mean to restrict himself to overt and observable actions. Indeed, the kernel of his theory is that every state of mind can be resolved into some fact about the behaviour of our neurones.

5) This doctrine has been characterized by Broad as 'an instance of the numerous class of theories which are so preposterously silly that only very learned men could have thought of them'.[3] And certainly it does seem absurd to hold, not merely that thinking, feeling, and desiring are dependent on changes in our body, but that they actually *are* such changes. Even in the case of sense-perception, where we know, for example, that, when we see a blackbird, there is always a particular kind of activity in our nervous system—the stimulation of the eye, the transmission of nervous impulse along the optic nerve, etc.—we may well hesitate before

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[1] *The Measurement of Intelligence*, p. 415.

[2] *Psychology from the Standpoint of a Behaviourist*, p. 2 note.

[3] *The Mind and its Place in Nature*, p. 623.

declaring that our seeing of the blackbird *is* this neural process. To say that *A* causes, or is invariably associated with, *B* does not mean that *A* is identical with *B*: in fact, the two statements are incompatible.

a) Common sense believes that mental characteristics are other than material. Of course, this may conceivably be a delusion. It may be that the solving of a mathematical problem, or the enjoyment of a novel, is merely a physiological event. But, in admitting this possibility of delusion, we are only admitting our general liability to error in everything—even in thinking that there are material bodies and physiological processes. There is no *special* reason for doubting that mental processes occur. If we cannot be certain about the existence of our mind, we cannot be certain about the existence of anything else. There is not the slightest justification for saying that a headache is any less real than a head, or the emotion of fear than the earthquake that occasioned it, or thoughts about the Suez Canal than the canal itself. The occurrence of mental processes is no more doubtful than the occurrence of physical events; and, in fact, the need or room for doubt is negligible in both cases.

b) The situation would be very different if minds, in the usual, non-material sense, were, as some Behaviourists affect to believe, mere unobserved entities, whose existence we hypothesize in order to explain certain aspects of behaviour, such as the avoiding of obstacles and the appropriate answering of questions. If the belief in the existence of minds were simply an explanatory hypothesis—or, as others say, a 'postulate' or 'assumption'—perhaps we should have little ground for accepting it. In accordance with the scientific canon known as 'Occam's razor', *Entia non sunt multiplicanda praeter necessitatem*, we might be obliged to reject minds altogether.

In fact, however, our knowledge of mental processes b) ✓ is not thus inferential and precarious. Our ground for ascribing such processes to ourselves is not that we tentatively regard them as affording the most plausible explanation of some of the more puzzling of our actions. When we say that we are imagining Ivan the Terrible, or wondering how a square house could be built with all its four sides facing south, we are asserting the occurrence of a mental experience, and our reason for asserting it is not that we are induced to make the hypothesis, but simply that we directly observe the experience by introspection. Mental processes—processes having other than physical ✓ characteristics—are facts of which we are immediately aware.

c) Another objection to this Behaviourist theory is that, if mental processes were identical with cerebral processes, we could never be aware of any of our mental processes without being aware of some physiological process in our brain; whereas, in actual practice, we are often aware of our thoughts, and feelings, and desires, without having the least knowledge of what is happening in our brain. Moreover, on this theory, we could never distinguish between two of our mental experiences—as, for example, thinking about the square-root of two, and desiring to bathe in the Mediterranean—except by distinguishing between the two physiological processes which they are said to be; and this, too, is plainly false. In short, we know our mental experiences infinitely better than we know the physiological functions of our brain; and this is fatal to any attempt to identify the two.

d) Again, suppose, for the sake of the argument, that there are no minds, and that our belief in their existence is an untenable hypothesis. Still, since this erroneous belief does admittedly exist, we are faced by the problem how we ever came to entertain it. And is not Broad right when he says that 'if Behaviourism be true we all make a mistake which it would be impossible for us even to think of unless Behaviourism were false'?[1]

The theory that thoughts are merely movements in the brain, or in some other bit of matter, must therefore be rejected. There is no reason to give up the ordinary view that the statement 'Jones is thinking about his overdraft' refers to a state of mind, and not to any physiological process that may accompany it. And, in rejecting extreme Behaviourism, we necessarily reject physiological definitions of intelligence. Any attempt to resolve intelligence into 'a function of the central nervous system', or non-mental 'effectiveness of adjustments'—two of the attempts at definition that we quoted—must be regarded as mistaken.[2]

But those who use physiology in their accounts of intelligence are not all extreme Behaviourists. Some of them, while realizing that intelligence cannot be analysed or defined in physiological terms, nevertheless believe that it has a physiological counterpart or cause, and that statements about this counterpart or cause throw most light upon it. They agree that minds exist, and that mental experiences are different in kind from anything that could be observed in a brain; yet they hold that we can best describe and mark off different mental characteristics by laying bare the physiological characteristics with which they are severally associated.

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[1] Op. cit., pp. 615–16.

[2] It may be observed that, even if intelligence *were* a physiological characteristic, these definitions would fail to particularize it. To say, for example, that intelligence is 'a function of the nervous system' does not distinguish it from sleep, which is also such a function.

In some instances the advocates of this view assert a) merely a general parallelism between mental and physiological processes and give no priority either to the one kind of process or to the other. Other psychologists, however, set forth the Epiphenomenalist doctrine, arguing that the mind, at every point, depends upon the body—that mental processes, however valuable intrinsically, are caused solely by physiological activity, and are themselves the cause of nothing. b) Thus Douglas declares that every mental phenomenon is 'a property, an inherent attribute, of the matter concerned, evidencing by its changing phases the underlying physical activities of which it is the passive c) psychic expression'.[1] Similarly, according to Allport, consciousness, though it exists, and should be studied, 'is in no way a cause of bodily reactions', and 'does not explain events'.[2] Mental states are, in short, the interesting but ineffective by-products of certain changes in our nervous system.

Obviously, since both Psycho-physical Parallelism and Epiphenomenalism allow that minds exist, they are entirely different from extreme Behaviourism, and ✓ escape the objections that we raised against it. But, e) granting that these theories rightly do not purport to reduce intelligence—or any other mental quality—to something physiological, we may still ask whether they are right in holding that the best guide to the nature f) of intelligence is a description of its physiological parallel, or cause. Many people, of course, would condemn both theories on the ground that it is absurd to f1) suppose that a mental characteristic like intelligence could have any physiological parallel, and even more absurd to say that it is the mere effect of a physiological cause. But these are not criticisms that we are at all disposed to make. What impresses us is the fact that, even if Psycho-physical Parallelism or Epiphenomenalism be true, it is impossible to describe intelligence by reference to physiology, for the very simple reason that its physiological counterpart is still unknown.

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[1] *The Physical Mechanism of the Human Mind*, p. 239.

[2] *Social Psychology*, pp. 2–3.

This is made plain by Allport, who, as we saw, advocates Epiphenomenalism. Allport's general method is to explain all human thought and action by reference to the physiological mechanism that embraces stimulation, neural transmission, and response. In his view, whenever we act, it is only because some stimulus has affected one of our internal or external sense-organs, and this has caused nervous impulse to pass through our nervous system and provoke a muscular or glandular response. Consciousness, when it occurs, is merely a collateral effect of this chain of physiological events. Still, he insists on the fact that, in describing, as distinct from explaining, processes of mind, introspection 'is both interesting in itself and necessary for a complete account'.[1] And when he comes to deal with intelligence, his customary care and candour lead him to show the impossibility of describing it by recourse to physiology. Thus he states that it is 'the capacity for solving the problems of life', or 'the capacity for reasoning', and that it comprises 'perceptual ability', 'constructive imagination', and 'soundness of judgment'.[2] Whether his description be adequate or not, Allport is admittedly compelled to use only psychological terms. Although he wants to refer to the bodily correlate of intelligence, he finds that, in the existing state of our knowledge, he cannot do so.

In this connexion we may also consider the work of Thorndike. He, like Allport, believes that mental phenomena exist, although they depend on physiological causes. He also resembles Allport in making several statements about the psychological factors that intelligence comprises. But, unlike Allport, he does bring into his description of intelligence a reference to physiology. Thus he advances the view that 'in their deeper nature the higher forms of intellectual operation are identical with mere association or connexion forming, depending upon the same sort of physiological connexions but requiring many more of them'.[1] He amplifies this statement as follows; 'Let *c* represent whatever anatomical and physiological fact corresponds to the possibility of forming one connexion or association or bond between an idea or any part or aspect or feature thereof and a sequent idea or movement or any part or aspect or feature thereof. Then if individuals, I_1, I_2, I_3, I_4, etc., differing in the number of *c*'s which they possess but alike in other respects, are subjected to identical environments, the amount or degree of intellect which any one of them manifests, and the extent to which he manifests "higher" intellectual processes than the other individuals, will be closely proportional to the number of *c*'s which he possesses.'[2]

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[1] Op. cit., p. 3.

[2] Ibid., pp. 104–5.

Thorndike does not, however, regard 'number of *c*'s'—or *C*, as he collectively names them—as the sole cause of intellect. 'There is', he says, 'also perhaps a capacity for having the neurones act with reference one to another, that is, with integration, whose low or negative extreme is pronounced dissociation as in hysteria, and whose high or positive extreme appears as a notable goodness or adequacy in the use of one's experiences.'[3] And, in his view, this capacity—no less than other relevant factors—may be 'largely irrespective of *C*'.

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[1] Op. cit., p. 415.
[2] Ibid., pp. 415–16.
[3] Ibid., p. 431.

These statements represent the salient features of Thorndike's reference to physiology. They show that, apart from such important qualifications as that intelligence may be influenced by 'a capacity for having the neurones act with reference one to another, that is, with integration', his theory does, as he claims, make intelligence depend simply on the quantity, not on the quality, of certain physiological processes. They also show, however, to what straits a distinguished psychologist is reduced when he tries to specify the neural correlate of intelligence.

The meaning of the phrase 'having the neurones act with reference one to another' is especially obscure; and this is a great pity in view of its apparently disastrous effect on his attempt to present a purely quantitative theory. But, even if this be left aside, it is still plain that Thorndike fails to define the physiological facts, in terms of which, according to him, differences in intelligence must, 'in the last analysis', be described. His very use of a symbol, *C*, shows that what he wants to refer to is unknown. The most he can say of *C* is that it consists of a number of *c*'s, of each of which we know only that it represents 'whatever anatomical and physiological fact corresponds to the possibility of forming one connexion or association or bond' in our mind. In short, while claiming that the nature of intelligence can be clarified only by reference to its physiological cause, Thorndike cannot specify this cause. He can say no more about it than that it comprises whatever physiological factors underlie the psychological ingredients of intelligence! It is as though one should seek to describe *A* by reference to *B*, and then find that *B* cannot be described except by reference to *A*.

An examination of the treatment of intelligence by Allport and Thorndike thus confirms the view that at present the physiological parallel, or cause, of intelligence is unknown, and so cannot afford us any illumination. This, of course, does not mean that intelligence is uninfluenced by physiological conditions. As we shall show in a later chapter, there is abundant evidence of the connexion between bodily and intellectual well-being. Nor does it mean that intelligence has no physiological parallel or cause. It merely means that at present we have not discovered what this cause or parallel is. In this year, 1948, no one knows precisely what variations in the brain are correlated with variations in the intellect.

There is a further point. Even if we could now specify the physiological counterpart of intelligence, how could we profitably use it in any attempt to describe intelligence itself? No doubt we may some time be able *to explain the occurrence* of mental processes by reference to facts of physiology—to show, in terms of cerebral activity, why we think of Bristol one minute and of Marcus Aurelius the next, and why James is bright and William dull. But we shall never be able *to describe the nature* of mental processes by reference to such facts. People who suppose otherwise assume that, in specifying *A*'s cause, we must thereby, to some extent at least, describe *A* itself. This assumption, however, is false. Our colour-sensations are ultimately caused by light-waves, and our auditory sensations by air-waves. But we cannot describe the nature of colours or sounds by reference to the light-waves or air-waves that respectively explain their occurrence. Redness, although caused by light-waves, does not itself consist of light-waves and cannot be described by reference to them. Similarly, the sound middle C, although caused by air-waves, does not itself consist of air-waves, and no reference to air-waves can elucidate its own nature.

We conclude, then, that all attempts to analyse, or even to describe, the essence of intelligence by recourse to physiology must necessarily fail.

CHAPTER V

INTELLIGENCE TESTS

'Intelligence tests are commonly criticized, most commonly by persons who have little understanding of the way in which they are used. They are blamed for failing to measure things which they are not intended to measure; character, for example, and artistic talent.'—ANGUS MACRAE: *Talents and Temperaments.*

HAVING dealt with the nature of intelligence, and with the impossibility of describing it in physiological terms, we come now to intelligence tests. In this chapter we shall deal with the way in which they are constructed and standardized; in the next chapter with the facts about intelligence that they have revealed; and in the last chapter with the purposes for which they are being profitably employed.

We notice at once the important and comforting fact that, however much opinions may differ about the ultimate nature of intelligence, there is, to quote Macrae, 'close agreement as to the procedure by which intelligence may best be measured'. Spearman, as we have seen, regards intelligence as the general factor that enters into all our cognitive abilities; Thomson doubts whether there is any such general factor; and Binet declared that 'the mental faculties of each subject are independent and unequal'. Nevertheless, the tests constructed by these three psychologists resemble one another closely.

In the first place, they all, although for different reasons, employ a medley of problems. Spearman uses a medley of problems for the reason that, since, on his two-factor theory, every problem involves a specific factor as well as the general factor, a diversity of problems is necessary to make the effects of the various specific factors neutralize each other, so that the result of the test is a measure of intelligence alone. Thomson and Binet, on the other hand, use a number of different problems because they believe that intelligence itself may be a compound of several factors, each of which must be called into play.

Moreover, the tests of these psychologists are also alike in that they each contain not only a variety of problems but a variety of problems of the same kinds. This is because, even among those who hold opposite views on the question whether intelligence is a single general factor or a combination of different factors, there is little disagreement about what activities most involve intelligence.

THE CONSTRUCTION OF INTELLIGENCE TESTS

Some people suggest that, because minds cannot be placed between callipers or poured into burettes, they must be completely immeasurable. But this is a mistake. Men have been assessing each other's knowledge, and ability, and character, ever since human society came into existence. Indeed, the ordinary type of examination, with which school pupils and university students are frequently confronted, is nothing but a more or less successful attempt to measure mental qualities. It is true that this type of examination aims at measuring mental achievement more than mental capacity. Still, it is a measure of minds.

Early attempts to measure intelligence depended on the double assumption that differences in intelligence are correlated with differences in physical traits and that we know in detail what this correlation is. Phrenology, for example, regarded the skull as the index of the mind, and associated different 'bumps' with different mental characteristics; physiognomy declared that abilities and temperamental qualities are revealed by the structure of the face; and graphology held that the mind is revealed by handwriting. These methods, however, are untrustworthy. There may possibly be some correlation between mental capacity, on the one hand, and characteristics of the skull, or the face, or the handwriting, on the other; but, even if such correlation exists, we do not know what it is.

During the last part of the nineteenth century there were many attempts to measure intelligence by measuring such simple mental functions as are involved in making a prescribed muscular response to a sensory stimulus, and in distinguishing fine differences in sensations of pressure or touch. But these attempts were unsuccessful. It was found that the simple mental functions are only slightly correlated with intellectual activities, and that they therefore provide no secure foundation for measurements of intelligence. Indeed, when tested with the aesthesiometer, an instrument for measuring our ability to distinguish between tactual stimuli, adults were discovered to be actually inferior to children of seven.

Modern intelligence tests do not measure physical qualities or merely sensory capacities. They seek to assess intelligence in a more direct and reliable manner. For the provision of a sound theoretical basis for these a) tests we are again indebted to Spearman's two-factor theory. That theory, as we have said, entails that an intelligence test shall contain a number of miscellaneous problems, since it is only in this way that the test can yield a measure of that general ability which is intelligence. But there is a second fundamental requirement. The different problems must all be problems that are influenced greatly by intelligence and little by the various specific abilities and group factors that they also require.[1]

b) To Burt chiefly belongs the credit of having shown what problems are highly saturated with intelligence. His researches were carried out among school-children in Oxford and Liverpool, and he showed that tasks involve general ability, or intelligence, in proportion as they involve relational thinking. At Oxford he applied to his subjects twelve tests, which ranged in complexity from those that required only sensory discrimination to one that demanded the reproduction of a complicated pattern exposed for very short intervals. He found that the more complex tests were the more highly correlated with intelligence. In the later experiment at Liverpool, where tests designed to evoke still higher mental capacities were employed, similar conclusions were reached. It was discovered that the tasks which common sense regards as the more 'intellectual'—those which demand relational, constructive thinking—are the better tests of intelligence.

It must be noted, however, that, although Burt's findings have been amply confirmed, his method of determining what kinds of problem most involve intelligence was not that which would now be employed. Like other investigators at that time, he used teachers' estimates as criteria with which to compare the validity of his tests; he regarded those tests as best whose results were most highly correlated with estimates of the children's intelligence made by their teachers. Spearman has shown, however, that, while such estimates do possess some degree of reliability, it is unnecessary to rely upon them. We can now employ an exact mathematical criterion to assess the extent to which any particular type of problem measures intelligence.

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[1] Cf. *The Abilities of Man*, *passim*.

Still, Burt's conclusions were right. The application of Spearman's criterion to the results of his tests has confirmed the inferences that he drew. The best problems to include in an intelligence test are those that involve the discovery of relations and the eduction of correlates.

Among these problems the following types may be selected for mention:

1. *Synonyms and Antonyms.* One word is given, and the subject is required to select or to supply a second word which has the same or the opposite meaning. Or two words may be given, and then the subject must show, by underlining either 'same' or 'opposite', whether the two are synonyms or antonyms.

Examples:

(i) Kind means the same as (*soft*, *friendly*, *lovely*, *darling*).

(ii) Assert is the opposite of (- - - - - - -).

(iii) Flabby and brittle are (*same*, *opposite*).

2. *Classification.* A set of words is given, and the meanings of all the words but one are in some respect alike. The subject has to underline the odd word.

Examples:

(i) *Shoot*, *stab*, *paint*, *choke*.

(ii) *Trumpet*, *drum*, *table*, *violin*.

3. *Sentence Completion.* An incomplete sentence is given, and the subject must select or supply the word, or words, that best complete it.

Examples:

(i) Man is perhaps the only animal that has the - - - - - - - to reason.

(ii) The burglar left the spoons behind because he saw they were not (*his*, *clean*, *silver*, *wanted*).

4. *Mixed Sentences.* A set of words is given, and the subject is required to say whether, when the words are correctly arranged, the resulting statement is true.

Examples:

(i) Newspaper reports of are the in events published (*true*, *false*).

(ii) Clever escapes a justice always criminal (*true*, *false*).

(iii) Of they are many themselves which guilty faults condemn (*true*, *false*).

5. *Codes.* A statement is given, and the subject has to put it into a code.

Examples:

Code the following messages on the principle that each word must first be reversed, and that for each letter there must then be substituted the next but one after it in the alphabet:

(i) Fifth battalion to return to base.

(ii) Reinforcements will not be needed.

6. *Number Series.* A series of numbers is given, and the subject must select or supply the two numbers that continue it.

Examples:

(i) 2, 6, 11, 17, (*21*, *24*, *28*, *32*, *34*).

(ii) 64, 16, 4, 1 (- -, - - -).

7. *Analogies.* Three words, of which the first two are in some way related, are given, and the subject

must select or supply a fourth word which is related to the third as the second is to the first.

Examples:

(i) Sun is to dry as rain is to (*cloud*, *shower*, *wet*, *pool*).
(ii) Piano is to tune as pencil is to (*trumpet*, *sketch*, *pen*, *rubber*).
(iii) Black is to white as good is to (------).

8. *Inferences.* A problem demanding reasoning is given, and the subject must select or supply the solution.

Examples:

(i) Only bad people lie or steal. Since Mary is good, she will (*lie*, *steal*, *do both*, *do neither*).
(ii) Three boys are sitting in a row. Harry is to the left of Willie, George is to the left of Harry. Which boy is in the middle? (--------).

The eight types of problem that we have described and illustrated do not exhaust those that involve relational thinking and are therefore appropriate to intelligence tests. And they are not always presented in the forms that we have employed. Thus often a problem in inference is presented in the form of a problem in sentence-completion, and the 'true-false' method is used instead of the 'multiple-response' method. Moreover, as we have indicated, sometimes the subject must supply the correct answer, whereas at other times he is required to select it from a number of given answers. Usually, however, the 'selective' method is preferred to the 'inventive' method, because it makes the marking of the test easier and more objective. A further point, which needs to be stressed, is that, though we have given examples only of verbal tests, many of the eight types of problem can be set and solved by means of diagrams or pictures instead of words.

For instance, problems that involve classification, completion, codes, analogies or inferences can all be posed and answered in this non-verbal way.

e) Some tests—as, for example, those constructed by Binet and Simon—include a type of problem that does not necessarily involve relational thinking. This is the 'information question', the answer to which, it is assumed, is sure to be known unless there is lack of intelligence. In Binet's test such questions as 'What day of the week is to-day?' and 'Are you a little boy or a little girl?' are asked. No one, of course, says that these problems measure intelligence directly, for they may be answered simply by memory. The claim is that they call only for knowledge which, at the given age and in the given community, none but the sub-normal can have failed to acquire. Nevertheless, modern practice discourages the use of such tests, on the double ground that, like all tests of information, they may be unduly influenced by instruction, and that in any case they are unnecessary.

Of course, all problems involve some degree of knowledge—knowledge of the words, figures, or other media by which the problems are presented. But no problem should be a test merely of knowledge. The amount of knowledge called for should be the minimum required for the setting and solution of the various problems, which must themselves be measures, not of information, but of relational thinking. It goes without saying that the knowledge required should never be 'special'; it must always be such as the person being tested cannot well have avoided.

Having now seen what kinds of problem are good measures of intelligence, we must note that intelligence tests may be designed either for application to individuals or for application to groups. The best known of the 'individual tests' is that constructed by Binet and Simon.

This was first published in 1906, and, in one or other of its revisions,[1] it is now used all over the world, especially in the testing of young children and in the diagnosis of mental deficiency. The Binet Scale, as it is called, consists mainly of tests of the oral question-and-answer type; it is, as Thorndike has said, really an elaborate standardized interview. Thus in one of the tests appropriate to the average child of eight, the examiner says: 'I'm going to name two things and I want you to tell me how they are *alike* and how they are *different*. In what way are a cricket-ball and an orange alike, and how are they different?' And the same form of question is repeated in relation to aeroplane and kite, ocean and river, penny and shilling. Similarly, in one of the tests appropriate to the average child of eleven, the child is asked what is foolish about this statement: 'When there is an accident the last carriage of the train is usually damaged most; so they have decided that it will be best if the last carriage is always taken off before the train starts.'

These are examples of verbal tests. They both demand the intelligent manipulation of words, or rather of ideas expressed in words. But, as we saw, there are also non-verbal tests, which demand the intelligent manipulation of pictures, diagrams or other concrete material. Thus one of the tests for year three requires the child to make a bridge with three blocks; a test for year four requires him to add a leg, the arms and the nose or mouth to an incomplete drawing of a man; and a test for year six requires him to trace the correct path in three simple mazes. Some scales are entirely composed of tests that demand only the manipulation of objects. But these performance tests, as they are called, are unreliable measures of intelligence, particularly among older children and adults. The tasks they comprise depend to a large extent on special abilities, and they are imperfectly standardized.[1]

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[1] The version that is now most widely used in English-speaking countries is the Terman-Merrill New Stanford Revision, Forms L and M. This was published in 1937 together with Terman and Merrill's explanatory manual, *Measuring Intelligence*. In several respects it is superior to the old Stanford Revision of 1916: for example, many of the information questions have been expelled, and some non-verbal problems have been introduced. But it has been severely criticized by Burt, Cattell, Kent and Spearman, chiefly on the ground that many of its problems depend too little on general intelligence and too much on group factors, and that some of them are not assigned to their appropriate ages. These criticisms are discussed by Vernon, *The Measurement of Abilities*, pp. 183–96. Meanwhile, revisions of Form L for British children have been prepared both by Burt and by Kennedy Fraser.

It is obvious that the application of individual tests, whether verbal or non-verbal, takes a long time; and, when a considerable number of individuals must be examined, a test that the group can perform together is much more convenient. Although Spearman has constructed a 'group' test in which the questions are read out to the candidates, most group tests are printed booklets, in which the problems are read by each candidate for himself. Usually a group test comprises a number of sections, each of which contains a fairly large number of problems of one particular kind. Spearman's test, for example, has seven sections, covering seven of the different types of problem that we illustrated above. These sections contain altogether 163 problems, which are allowed eight seconds each. A test constructed by Burt and published by the National Institute of Industrial Psychology as 'Group Test No. 33', comprises 50 same-opposite problems, 30 sentence-completion problems, 30 mixed sentences, 25 analogies, and 18 problems of reasoning. In this test the candidate gives his answers simply by underlining particular words, or phrases, or figures; and, since some of the problems are multiple, approximately 200 underlinings are asked for, each correct underlining being given one mark. The candidates are instructed to work as quickly as possible, and a definite time is allowed for each section, the time allowed being such that the brightest candidate can scarcely complete any section. The total time occupied is about half an hour. Similarly, the d) Terman Group Test, in either of its forms, consists of ten sections, for which periods varying from two to four minutes are allowed.

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[1] These strictures apply only to performance tests, not to all non-verbal tests. Some non-verbal tests—for example, those that involve the intelligent interpretation of diagrams—have been found very reliable. Of the performance tests the Drever-Collins Scales are probably the best, but even they are not unexceptionable.

2) In some group tests—as, for example, Richardson's 'Simplex' Test—the different sections are not separately timed, although there is a time limit for the test as a whole. In these 'omnibus' tests, as they are called, the different kinds of problem usually recur in regular cycles, one series of short sections being followed by a second series containing similar problems, and perhaps by a third series and even a fourth. This method ensures that the candidate shall attempt every kind of problem, even if he is unable to complete more than half the test in the time allowed.

Group tests were first applied on a large scale during the First World War, when the American Army authorities decided to examine the intelligence of their recruits in order to discover those who might prove suitable for promotion, to enable platoons to be made equal in mental capacity, to allow the bright and the dull to be trained at different rates, and to eliminate men whose low intelligence made them unfit for military service. These Army Group tests—the Alpha Test f) for the majority of the recruits and the Beta Test for those that were illiterate or foreign-speaking—were prepared by a committee of outstanding American psychologists, and they were based on material already provided by Burt, Otis, Pintner, and others. The number of recruits examined was nearly two million, and data of great theoretical and practical value were collected.[1]

After the war, the Alpha Test, and many other group tests modelled more or less closely upon it, were applied to pupils in secondary schools and to students in universities; and soon forms suitable for children in elementary school, and even for infants, began to appear. At present numerous group tests are being employed in Great Britain, America, and many other countries. Ten years ago, for example, the Scottish Council for Research in Education had a specially constructed test applied to over 60,000 children in Scotland.[2] And another group test was applied in 1947 to all Scottish children aged eleven.

There are, then, individual and group tests of intelligence, and both kinds consist of a variety of problems, each of which must be saturated with relational thinking so that the general factor, or intelligence, exercises the preponderant influence on its solution. In the construction of tests, however, there are four other matters to which we must pay attention. (i) Every test must itself be thoroughly tested; faults in the material must be detected and removed, the relative difficulty of the problems must be determined, and there must be careful investigation into the time allowances that are required. (ii) Every test must be adapted to the range of intelligence of those for whom it is intended; it must be neither too easy nor too difficult for the candidates, but must yield such a distribution of scores as will permit the performances of the candidates to be distinguished. This adaptation—like the various processes by which the different problems are 'weighted'—is an arduous and expert operation. (iii) The separate problems must all be stated plainly, and in the same terms to each candidate. This applies to individual tests of the oral question-and-answer type as well as to printed group tests. (iv) The marking of the test must not be liable to bias, conscious or unconscious, on the part of the examiner. Each question must have only one right answer so that every individual's performance will obtain the same score by whomever it be marked.

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[1] Cf. Yoakum and Yerkes, *Mental Tests in the American Army*; and Brigham, *A Study of American Intelligence.*

[2] Cf. *The Intelligence of Scottish Children*, a survey by the Scottish Council for Research in Education.

THE STANDARDIZATION OF INTELLIGENCE TESTS

We have now described how an intelligence test is constructed—the kinds of problem that it must contain and other conditions that it must fulfil. But, of course, it is not enough to know that a particular test is a good test of intelligence. A standard or norm, with which we can compare any individual's score, is also required.

In this respect measurement of intelligence resembles measurement of height—or, indeed, of any thing else. Suppose, for example, that we know the height of a particular boy of thirteen. If we want to know whether he is tall, normal, or short, we must have some standard with which to compare him, and we should find it in the average height of boys of thirteen. Similarly, suppose we know what score the boy obtains in an intelligence test. This can tell us nothing about his brightness or dullness until we compare it with its appropriate norm.

It was in this connexion that the work of Binet was of outstanding importance. Reference has already been made to his individual tests. Their most valuable feature was that they embodied a scale. The need for a standard or norm was made especially obvious to Binet by the very nature of his problem, which was to devise a method of selecting those children in Parisian schools who should be taken out of the ordinary classes and placed in special classes for defectives. And he secured it by an admirably simple method.

First of all, he devised a number of miscellaneous tests, and applied them to large numbers of children of different ages. He then found, for each test, at what age it was passed by the average child. Thus the average child between seven and eight, was found capable of counting backward from 20 to 1, and the average child between three and four of repeating the sentence 'We are going to have a good time in the country'. The various tests being thus arranged in order of difficulty, Binet used this arrangement as a scale, or frame of reference, against which he could measure any individual. If, for example, a boy of four could do the tests that were passed by the average child of five, he was held to be a year above average. In the same way, if another boy, aged ten, could do only the tests that are passed by the average child of seven, he was three years below average.[1]

M.A. At this point Binet introduced his valuable concept of 'mental age'—a person's mental age being the age at which the average person can pass the tests that he passes. In the two cases just considered, the first boy, although four in 'chronological' age, has a 'mental' age of five, since his performance is equal to that of the average child of five. The second boy, although ten years old, has a mental age of seven.

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[1] Binet's method of determining to what age a particular test should be assigned was imperfect. The correct method, as Burt has shown (*Mental and Scholastic Tests*, p. 140), is to group children, not, as Binet grouped them, by their age at their *nearest* birthday, but by their age at their *last* birthday. Thus the average age of the groups is 3½, 4½, 5½, etc., not 3, 4, 5, etc., as in Binet's method. A test is then assigned to Year Five if it is passed by 50 per cent of children in their fifth year, *i.e.*, by 50 per cent of children in the group whose average age is 4½.

The concept of mental age provided Binet—and, through him, other psychologists—with the required standard. It enabled us to state scores in intelligence tests in terms of a norm. In the early days of testing it was customary to express an individual's result by the difference between the mental age and the chronological age. Thus our first boy would have been said to be 'one year advanced', the other to be 'three years retarded'. It was soon found, however, that a given period of retardation is more serious in a young child than in an older child, and that it is rather the ratio of the mental age to the chronological age that matters. Hence the 'mental ratio' was introduced; a boy of ten with a mental age of twelve had a mental ratio of 1·2, and a boy of eight with a mental age of six had a mental ratio of ·75.

The mental ratio was later replaced by the intelligence quotient, which is the mental ratio multiplied by 100, or, in other words, the percentage that the mental age is of the chronological age. For example, a boy of nine years and two months, who has a mental age of ten years and one month, possesses an intelligence
I.Q. - quotient, or I.Q., of 110. Clearly, since the mental
Stern age of the average child is equal to his chronological age, the average I.Q. is 100.

M.R. The mental ratio, or M.R., and the intelligence quotient, or I.Q., are thus based on the concept of mental age. It has been found, however, that, whereas intelligence develops evenly throughout childhood, the I.Q. remaining relatively constant from year to year, there is no appreciable growth in intelligence after the age of sixteen. This means, of course, that the average adult has a mental age of sixteen—that his performance at the tests does not excel that of the average person aged sixteen. How, then, are we to express the intelligence of an adult whose performance does excel that of the average person of sixteen? His capacity is higher than a mental age of sixteen would denote, and yet we cannot say that he has a higher mental age, because there is no such thing.

This difficulty has been surmounted. We know that intelligence is distributed among the population in accordance with the normal curve of probability. The number of individuals grows less as the distance from the average increases; and, what is more important here, there are just as many individuals at any point above the average as there are at the corresponding point below the average. Consequently, if we discover that 25 per cent of persons aged sixteen have mental ages below fourteen and a half, and, therefore, I.Q.'s of less than 90, we know that there are 25 per cent with I.Q.'s greater than 110. We can then examine the distribution of test scores and find what score is exceeded by 25 per cent of persons aged sixteen, and we can say that that score, when achieved by persons of sixteen or over, represents an I.Q. of approximately 110. And in the same way we can determine what I.Q. is indicated by any other score that is better than the average.

→ So far we have been referring to norms that depend, directly or indirectly, on the concept of mental age. A different method of standardizing intelligence tests R is that of the 'percentile rank'. When this is employed the scores of a representative sample of comparable individuals are first arranged in order of merit and then divided into a hundred equal groups or percentiles, the best being given the rank of 100, the worst the rank of 1, and the average the rank of 50. The percentile rank of any score is the rank of the percentile group in which it falls. Thus among adults, a score with a percentile rank of 60 would be better than 59 per cent of the scores of adults, but worse than the remaining 40 per cent. And, among Scots children aged eleven, an individual whose scores had a percentile rank of 35 would be more intelligent than 34 per cent, and less intelligent than 65 per cent, of the total group.

The percentile rank is a convenient and useful device, which is being increasingly employed not only in standardizing intelligence tests but in standardizing other forms of examination. It is of course a very different thing from a percentage mark. 'The statement that a boy has gained 75 per cent of the possible marks in a test', says Macrae, 'conveys no exact indication of the quality of his performance. The mark may be a very good one or a very indifferent one; it all depends on the difficulty of the test. A percentile rank, on the other hand, can have only one meaning, and its meaning is very definite and precise.'[1] It means that the boy is superior to 74 per cent of the individuals with whom he may reasonably be compared.

Percentile ranks—P.R.'s—can be converted into I.Q.'s. This also follows from the fact that intelligence is normally distributed throughout the population, and that we know what percentage of people have I.Q.'s of any particular range. We find, for example, that approximately 50 per cent of I.Q.'s are between 90 and 110; that there are 25 per cent below 90 and the same percentage above 110; and that there are 10 per cent below 80 and an equal number above 120. Hence, as will be readily seen, P.R.'s between 25 and 75 correspond to I.Q.'s between 90 and 110, a P.R. of 10 to an I.Q. of 80, and a P.R. of 90 to an I.Q. of 120.

We may say, then, that the I.Q., which is the formula usually employed to express performance in an intelligence test, has two meanings. For a person over sixteen, it denotes the relation of his intelligence to that of other adults—whether, for example, he is in the top 1 per cent of the population, or the top 25 per cent, or the middle 50 per cent, or the bottom 25 per cent, or the bottom 1 per cent. For a person aged sixteen or under, it denotes not only his relation to his contemporaries but also the percentage that his mental age bears to his chronological age.

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[1] *Talents and Temperaments*, p. 44.

Clearly, the standardization of an intelligence test involves the expert use of statistical methods. It also involves much time and labour, because, in order to establish norms, whether I.Q.'s or P.R.'s, we must apply the test to a representative sample of those for whom it is intended—a sample in which all the relevant differences in the whole group are represented in their proper proportions. Thus, when a standard for different ages is required, a fair sample of children at each age must be tested, and the distribution of scores for each age must be determined. Similarly, if we wish to find norms for adults, we must apply the test to a sample that truly represents all adults.

THE APPLICATION OF INTELLIGENCE TESTS

The difficulty underlying the construction and standardization of tests does not affect their application. 'Individual' tests of the oral question-and-answer type do require practice and skill.[1] But 'group' tests can be administered by any averagely intelligent adult. They all contain simple and clear instructions showing how they must be applied and marked; they give norms with which the performance of any individual may be compared; and usually they add a convenient table which enables any score to be readily converted into an I.Q. The examiner merely hands out the booklets, controls the time allowances, marks the candidates' performances or gets the candidates to mark each other's, and then turns the scores into I.Q.'s.

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[1] Cf. Terman and Merrill, *Measuring Intelligence*, where careful directions for the application of the new Stanford Revision of the Binet tests are given.

COMMENTS

Having now seen how a modern intelligence test is constructed and standardized, we can readily understand why competent judges agree that it provides a better measure of intelligence than any other at our disposal. a) But we may note that the validity of intelligence tests is also shown by the fact that their results are highly correlated with other activities in which intelligence admittedly plays a dominant part.) Thus they are correlated with success in those industrial, commercial, and professional occupations which chiefly require a general capacity for relational and constructive thinking.[1] They are also correlated with success in schools and universities. In Aberdeen, for example, we have found that, though of course some University students of high intelligence are surpassed in their work by less able but more industrious students, among the students as a group there is a significant relation between intelligence and attainment.

b) Nevertheless intelligence tests are not universally admired. We have suggested earlier that one reason for this is the fear which they sometimes excite. Since what they measure is not knowledge but capacity, they put the unsuccessful candidate in an awkward predicament, for he cannot explain away his poor performance on the usual ground that it is entirely due to his not being a 'swot'. Self-distrustful persons are therefore led to condemn the tests in advance, or, if they do undergo one, to treat it in a frivolous manner which they can subsequently use as an excuse for not having obtained the score they desired. This attitude is fairly common, especially among persons with a deserved reputation for ability, which they are needlessly afraid they may lose. It is difficult, for example, to resist the suspicion that some at least of the distinguished persons who say that an intelligence test has rated them as defectives did not really allow the test to do them justice.

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[1] Cf. pp. 81–2.

2) A second source of criticism is a mistaken notion of what an intelligence test sets out to measure. Some i) people do not grasp the fact that it is a test of ability, not of attainment. They are therefore shocked by its requiring so little knowledge, and regard this as a fault. ii) Other people expect the tests to rank candidates in their order of merit in respect of some special ability—such as the capacity for drawing, or for music, or for operating a machine. They, too, forget that the test is a test of intelligence. iii) And the same mistake is made by those who are discontented because tests sometimes place pleasant people below unpleasant people. A Scottish head master, for example, recently complained to a public audience that in his school one or two boys whose behaviour was unsatisfactory had actually got higher marks in an intelligence test than other boys of irreproachable morals and manners.

3) Still another reason why tests have been distrusted lies at the door of some who have constructed and used them. i) Spearman has shown how insecure was the theoretical foundation of many of the earlier tests, and he has cited many of the unfavourable comments that this lack of a sound basis was bound to provoke.[1] ii) Moreover, too much has often been claimed for the tests. Some enthusiastic persons, ignoring the fact that success in anything depends on special abilities and

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[1] Cf. op. cit., Chap. II.

on temperamental qualities as well as on intelligence, have foolishly said that intelligence tests by themselves are adequate criteria for all sorts of activities and occupations. And this extravagant claim has naturally aroused opposition.

(Of the criticisms commonly advanced, three are more important than the rest. The first is that a
4) person's score in an intelligence test is affected by the speed with which he can think. This cannot be denied. The number of problems in an intelligence test is, as we have said, usually such that even the brightest candidate can scarcely complete the test in the time allowed. But the fact that speed of thinking contributes to successful performance does not vitiate the tests, because only accurate answers receive any marks, and we are justified in regarding *A* as more intelligent than *B* if he can carry out a greater amount of accurate relational thinking in a given time.)

Spearman advances another argument in defence of our allowing speed to affect the results of an intelligence test. Relying on investigations conducted by Bernstein, and by Hart and himself, he claims that, while any increase in the speed of a mental operation tends to be accompanied by a decrease in accuracy, still people who possess the capacity for quick thinking tend also to possess the capacity for accurate thinking.[1] The common view is, of course, that there is a sharp distinction between people who can think quickly and people who can think well. But, if Spearman is right, this view, like the parallel view that those who learn slowly are best at remembering, is 'a most grave error', based perhaps in the false assumption that Nature behaves in a compensatory manner, counterbalancing each of our defects with a corresponding advantage.

Spearman also deals with the objection that a person's score in an intelligence test depends, not only on speed of thinking, but also, to some extent, on speed of reading and writing. He brings forward evidence in support of the view that the ability to read or to write quickly, like the ability to think quickly, is positively correlated with intelligence, and is therefore an unexceptionable factor in the performance of a test. This view, however, cannot yet be regarded as established, and the power of rapid reading or writing may give its possessors an undue advantage in intelligence tests as in other forms of examination.[1]

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[1] Cf. op. cit., Chap. XIV.

5) It is said, in the second place, that intelligence tests are unreliable because our ability to do them is influenced by education. Ten years ago, for example, Gordon arrived at the conclusion that 'from the results obtained among children who get most of their education at school and very little at home it is very evident that the mental tests do not measure their native ability apart from schooling'.[2] And this has sometimes been taken to involve a general condemnation of intelligence tests.

Spearman and some other psychologists do not accept Gordon's conclusion.[3] They point out that he used tests that included many 'information problems', which are usually omitted from modern intelligence tests. And they quote investigations that contradict his results—as, for example, that of Berry,[4] who divided a large group of children into three groups according to their results in an intelligence test, and found that those in the second and third grades had been to school just as regularly as those in the highest.

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[1] Several recent investigations into the relation between speed and intelligence have been made, and they have supported Spearman's view. It has been found that performance in intelligence tests where time is limited is highly and positively correlated with performance in the same tests when time is unlimited. In other words, persons who excel when speed affects the result also excel when it does not. Cf. Freeman, *Journal of Applied Psychology*, Vol. XII, pp. 631–5, and *Journal of Experimental Psychology*, Vol. XIV, pp. 83–90.

[2] *Educational Pamphlets*, No. 44, quoted by Spearman, op. cit., p. 385.

[3] Cf. Spearman, op. cit., pp. 385–8.

[4] Cf. *Journal of Educational Research*, Vol. VI. pp. 193–6.

We ourselves, however, are impressed by the evidence that education does affect our ability to do an intelligence test. Gordon's research does not stand alone, for Burt and others have reached the same conclusion.[1] But the fact—if it be a fact—that education affects our ability to do intelligence tests does not entail either that the tests do not measure intelligence or that they measure something more, for it may well be that education influences our ability to do the tests for the simple and perfectly legitimate reason that it helps to develop intelligence. Intelligence is a native trait, but it requires an appropriate environment in order to reach the maximum that has been set for it by heredity. The intellectual capacity of a born genius can be prevented from developing by damage to his brain during childhood, and, conversely, the growth of every one's intelligence is no doubt assisted by suitable schooling.[2]

6) A third criticism is that performance in an intelligence test is affected by emotional mood. To this Spearman replies that nervousness and lack of self-control tend to be reported more of those who do well than of those who do badly at the tests. From results obtained from persons of all ages, all social strata, and all grades of intelligence, he concludes that 'on the whole, the truth would appear to be that insufficiency of will power, nervous temperament, and susceptibility to complexes do handicap people in the prolonged, familiar

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[1] Cf. Burt, op. cit., p. 183.

[2] For evidence supporting this view, cf. Jennings, *The Biological Basis of Human Nature*, pp. 167–8; Thomson, *Instinct, Intelligence and Character*, pp. 216 sqq.; and *The Twenty-seventh Year Book of the National Society for the Study of Education.* Part I.

and monotonous occupations of ordinary life, but have no such effect on the brief, novel, and interesting performances constituting the tests'.[1] As a general statement, this is undoubtedly true. Most people, including nearly all children, do find intelligence tests, when they are actually engaged in them, enjoyable tasks: emotional hindrances are only rarely encountered. But here, as in any other form of examination, 'nerves' do place *some* people at a disadvantage, just as they doubtless help others. Their number is admittedly small. We do not dispute the fact, which experiments have established, that in intelligence tests most individuals, whether children or adults, are not handicapped (or, for that matter, helped) by their emotional attitude. Nevertheless, there is the odd individual who is so resistant or timid that he does not do himself justice.

The moral, however, is not that intelligence tests should be discarded, but that it is part of the technique of testing to prevent or dissolve those emotions and attitudes that spoil a person's performance. In short, the examiner must establish rapport with the examinee. Fortunately, this is usually not at all difficult, for, if the examiner is genuinely interested and friendly, and establishes a sympathetic and understanding relationship with whomever he is examining, most people enter confidently and wholeheartedly into the test. Certainly, it is more difficult to win the confidence and co-operation of the timid, sullen, resistant or otherwise exceptional individual. But this only means, as Terman has so often insisted, that the competent examiner needs more than the relevant scientific knowledge, that he must also possess intelligence, judgment, psychological insight and personal adaptability, and that therefore not everyone is fit to apply intelligence tests.

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[1] Op. cit., p. 339.

CHAPTER VI

FACTS ABOUT INTELLIGENCE

'We do, of course, differ in our inborn powers; but let it not become an inhibiting idea or an overweening obsession.'—C. A. MACE: *The Psychology of Study.*

THE use of intelligence tests has revealed many important facts about the distribution and growth of intelligence, and about its connexion with other aspects of human behaviour.

THE DISTRIBUTION OF INTELLIGENCE

We have already said that intelligence is distributed in accordance with the normal curve of probability. The number of individuals grows less as we move from the average in either an upward or downward direction, and there are just as many individuals at

Number of Heads	Number of Times
0	1
1	10
2	45
3	120
4	210
5	252
6	210
7	120
8	45
9	10
10	1
	TOTAL 1 024

any point above the average as there are at the corresponding point below it.

To understand the normal curve more precisely, let us suppose that we throw ten coins 1,024 times, and that we count the number that turn up each time. The table (on p. 65) represents the probable results.

The most frequent number of heads is 5, while 4 and 6, 7 and 3, 8 and 2, 9 and 1, and 10 and 0, appear with equal but decreasing frequency. From these figures we can construct the curve shown in Figure 1, which is the normal curve of probability.

Many variable traits of human beings are distributed in accordance with this curve. The height of men of the same race provides an example. Common observation shows that a great proportion of men are of approximately average height, and that extremely tall or extremely short men are comparatively rare. And this observation is confirmed by exact measurements of large representative samples of men, for such measurements closely follow the curve of probability.[1]

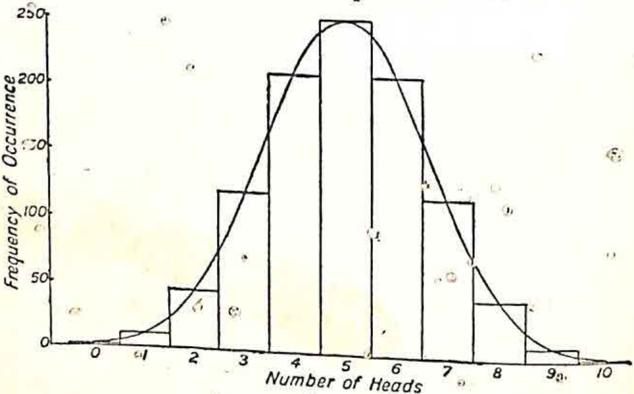

FIG. 1.

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[1] Cf. Sandiford, *Educational Psychology*, p. 26.

There is abundant evidence that intelligence is similarly distributed. Many years ago Terman found that the intelligence quotients of 1,000 unselected children followed the normal curve,[1] and this finding has been corroborated by himself and by many other investigators. In 1921, for example, Thomson found that 2,710 Northumberland school-children had the following intelligence quotients[2]:

I.Q.	Number of children
Below 60	21
61– 70	83
71– 80	226
81– 90	475
91–100	644
101–110	596
111–120	400
121–130	189
131–140	65
Over 140	11
	TOTAL 2,710

The curve that these figures yield is shown in Figure 2, and its resemblance to the normal curve in Figure 1 will be readily seen.

Knowledge of the way in which intelligence is distributed is of importance. As we saw in the last chapter, it enables us to say in what grade of the community any individual's I.Q. places him. Of course,

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[1] Cf. *The Measurement of Intelligence*, p. 66, and (with Merrill) *Measuring Intelligence*, p. 37, where the distribution of intelligence among 2,904 other children is recorded. Cf. also Macmeeken, *The Intelligence of a Representative Group of Scottish Children.*

[2] Cf. *Instinct, Intelligence and Character*, p. 173.

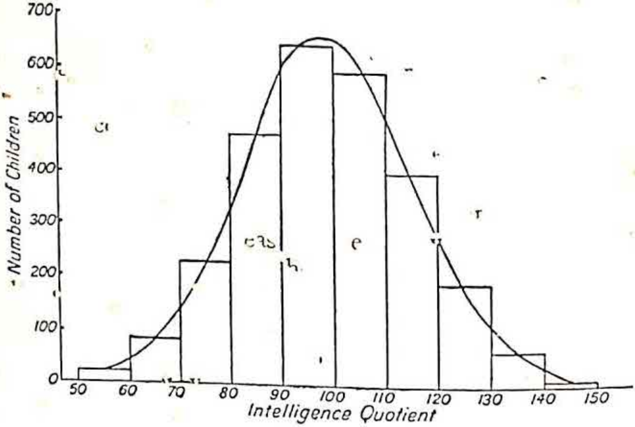

Fig. 2.

since the distribution is continuous, the divisions that we make are all bound to be arbitrary; we cannot draw a sharp line of demarcation at any point. But if we consider the results of Thomson's test, for example, it is clear that each child with an I.Q. above 130 was in the top 3 per cent, each child with an I.Q. above 110 was in the top 25 per cent, and so on. And the following divisions, provided they are not regarded as a sharply defined and immutable classification, have been found useful in practice:

I.Q.	Percentage of Cases
Above 130	2
Above 120	10
Above 110	25
90–110	50
Below 90	25
Below 80	10
Below 70	2

If we use this table as a rough guide, we may say of an individual with an I.Q. of 112 that he is in the top 25 per cent of the population; of one with an I.Q. of 97 that he is in the middle 50 per cent; and of one with an I.Q. below 70 that he is in the bottom 2 per cent.[1]

INTELLIGENCE AND HEREDITY

The use of intelligence tests has also shown clearly that intelligence depends on heredity. The most convincing evidence of this fact is to be found in the following table, which has been compiled by Sandiford from the researches of Wingfield and others.[2] It gives the coefficients of correlation for intelligence among groups exhibiting different degrees of blood relationship.

Groups	Correlation Coefficient[3]
Identical twins .	·90
Like-sex twins .	·82
Unlike-sex twins .	·59
Ordinary brothers and sisters .	·50
Cousins . .	·27
Unrelated children .	·00

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[1] This table, although exhibiting a normal distribution of intelligence, will be seen to be slightly different from that which Thomson's figures would provide; in particular, the percentage of cases with I.Q.'s above 130 and below 70 is smaller. The distribution of I.Q.'s, which depends on the degree of the dispersion of the scores, differs for different tests. If a group of people be given two different tests, the order of their scores will be substantially the same in both, but in one the scores may cluster more closely round the average than in the other.

[2] Cf. Sandiford, op. cit., p. 48; and Wingfield, *Twins and Orphans: The Inheritance of Intelligence.*

[3] When the correlation is perfect and positive, the coefficient is 1; when there is no correlation, it is 0. See pp. 8–9.

In other words, the amount of resemblance in intelligence varies from a coefficient of 0 for unrelated individuals, to a maximum of ·9 for identical twins. Intermediate values are found in accordance with the genetic relationship of the individuals. Therefore, it is argued, intelligence is an inherited trait.

Those who do not know how careful the investigations into this matter have been may suggest that the great resemblance among children of the same family is wholly due to the similarity of their environment. But such a suggestion would conflict with a number of facts. First, twins exhibit a greater degree of resemblance than other brothers and sisters, and yet the similarity of their environment is not significantly greater. Secondly, twins are as alike in intelligence at the age of five as they are at the age of sixteen. Thirdly, differences in intelligence are found among children of different heredity who have been brought up in the same orphanage and attended the same school.

Evidence of the influence of heredity on intelligence is also to be found in the correlation between the intelligence of children and that of their parents.[1] Burt applied intelligence tests to pupils in two different schools. One of these schools was a preparatory school, where almost all the boys were sons of men who had attained to intellectual eminence. The other was an elementary school, where the boys were mostly the sons of local tradesmen. In most respects, and particularly in the quality of the education provided, the two schools seemed to be on an equal footing. Nevertheless, the boys at the preparatory school obtained much higher scores in the tests.[1]

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[1] It is, of course, firmly established that much feeble-mindedness is inherited. Various studies of defective families through many generations have made this fact plain. Cf. Estabrook, *The Jukes in* 1915. (The 'Jukes' have had a continuous record of vice, crime, and feeble-mindedness ever since 1740, and have cost the United States several million dollars). Cf. also Gates, *Heredity in Man*, pp. 280 sqq., and Penrose, *A Clinical and Genetic Study of* 1280 *Cases of Mental Defect.*

A similar investigation was conducted by Pressey and Ralston. They gave an intelligence test to over 500 children and compared the children's scores with their fathers' vocations. This comparison revealed that the children whose fathers were engaged in professional or executive work were, as a group, markedly superior to those whose fathers were engaged in manual work.[2] And analogous results were obtained in a further investigation involving nearly 6,000 children.[3]

We must, however, be cautious in dealing with these results. No doubt the intelligence of children is positively correlated with the vocational status of their parents.[4] No doubt, too, the influence of differences in social environment on intelligence is often exaggerated.[5] Nevertheless we must not blind ourselves to the fact that intelligence has a much greater chance of being developed among children whose parents are wealthy and educated than among the children of penurious labourers. In short, the positive correlation that has been found to exist between intelligence and socio-economic status does not, by itself, afford any conclusive evidence of the relative influence on intelligence of heredity and environment.

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[1] Burt collected corroborative evidence during his London experiment. Cf. his *Mental and Scholastic Tests*, pp. 190–2.

[2] Cf. *Journal of Applied Psychology*, Vol. III, pp. 366–73.

[3] Cf. Book, *The Intelligence of High School Seniors.*

[4] Recent confirmation of this fact is to be found in Terman's analysis of the I.Q.'s of 2904 children in *Measuring Intelligence*, pp. 48–50.

[5] Lawrence found that even among orphans who had had the same environment from a very early age there was some correlation between the intelligence of children and the social status of their parents. Cf. *The Relation between Intelligence and Inheritance.*

It has often been claimed that racial differences in intelligence support the view that intelligence is an inherited trait. If intelligence did not depend on heredity, children of different races brought up in the same environment should obtain similar scores in an intelligence test. But the use of the Alpha Test in the American Army showed that there were marked differences among the 12,492 white recruits who had been born in foreign countries. Brigham has calculated the percentage of recruits of each nationality that exceeded the average native American.[1] The order of merit is as follows:

England	67	Belgium	35
Scotland	59	Austria	28
Holland	58	Ireland	26
Germany	49	Turkey	25
Denmark	48	Greece	21
Canada	47	Russia	19
Sweden	42	Italy	14
Norway	37	Poland	12

These results, however, require most cautious interpretation. Brigham has sought to refute the obvious criticism that the differences between the scores of recruits of different nations may have been due to differences in language and education. He points out that all these recruits, whatever their native language, understood English,[2] and that the 'language theory' is hard to reconcile with the fact that not only the English, Scots, and Canadians, but also the Dutch, Germans, Danes, Swedes, and Norwegians, were markedly superior to the rest. Moreover, Berry,[3] who studied over 10,000 white American school pupils, also reached the conclusion that there were significant, innate, racial differences in intelligence among them; and similar results have been obtained by Terman and others. Nevertheless, it is possible that the various national groups tested in the United States have not been representative samples of their different nations, and that they have differed from each other in their social background.

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[1] Cf. Brigham, *A Study of American Intelligence*, pp. 118 sqq.

[2] The non-English-speaking recruits were given the Beta Test, and we are not concerned with them here.

[3] *Journal of Educational Research*, Vol. VI., pp. 197–200.

There have been many comparative studies of the intelligence of white and coloured groups whose education has been approximately equal. Pressey and Teter, for example, applied tests to 120 coloured American children, aged between ten and fourteen, and compared their results with those of 2,000 white American children, They found that, on the average, the coloured children were two years behind the white children.[1] And similar results have been obtained by Derrick, who tested white and coloured university students, and by Arlitt and Murchison.

There are, then, many indications that intelligence depends on heredity, and no evidence whatever that it depends solely or mainly on environment. This is not to say that environment has no influence on the level of a person's intelligence. But the view that uniform environment wipes out individual differences is altogether unjustified, while the facts that point to the important influence of heredity are impressive.[2]

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[1] Cf. *Journal of Applied Psychology*, Vol. III, pp. 277–82.

[2] As we said before (p. 63), although heredity determines the limit of intelligence that we can reach, it alone cannot determine the degree that we actually attain. We may not fully develop our innate capacities. On the whole subject of heredity and environment in relation to intelligence the important source-book is *Intelligence: Its Nature and Nurture*, whose two volumes constitute the Thirty-Ninth Year Book of the National Society for the Study of Education.

This being so, it is depressing to learn that parents whose children are dull are more prolific than those whose children are bright. Yet such is the evidence. Dawson, for example, applied intelligence tests to 1,239 Glasgow children of approximately the same social status. He found that the birth-rate was higher in the families to which the dull children belonged, and, although the fatalities were also higher, the number of survivors was greater. And other researches, especially those of Cattell, have led to the same result. They suggest that, if the present positive correlation between dullness and size of family continues unchanged, a slow but serious decrease in the intellect of the whole population will ensue.[1]

INTELLIGENCE AND AGE

The results of intelligence tests have confirmed the obvious fact that intelligence grows. But they have also led to the conclusion, which is perhaps somewhat surprising, that this growth ceases about the age of sixteen. The exact age is disputed: some psychologists fix it at fourteen; Binet, Terman and Merrill fix it at fifteen; Otis and Monroe fix it at eighteen. But most users of tests are agreed that intelligence matures at some such age as sixteen.

This view is based on a study of the scores that people obtain in the tests. Ballard, for example, gave a test, in which the possible score was 34, to 2,000 persons of different ages, and the following average scores show no improvement after the age of sixteen, and not much after the age of fifteen[2]:

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[1] Cf. Dawson, *British Journal of Psychology*, Vol. XXIII, pp. 42–51; and Cattell, *The Fight for our National Intelligence*.

[2] *British Journal of Psychology*, Vol. XII, pp. 125–41.

Age	Average Score
11	13·1
12	14·4
13	15·1
14	17·4
15	18·5
16	18·9
17	18·9

Thomson has recorded the following scores in the Otis Advanced Test[1]:

Age	Average Score	Age	Average Score
10	55	18	130
11	68	19	130
12	80	20	130
13	90	21	130
14	100	22	130
15	110	23	130
16	120	24	130
17	127	—	—

These are but two examples of the abundant evidence concerning this matter. It is firmly established that our ability to do intelligence tests shows no improvement after our middle teens.

Thomson, however, is inclined to doubt whether this discovery entails that intelligence reaches its maximum at this stage of our life. He thinks that scores in the tests may cease to improve, not because intelligence ceases to grow, but 'just because it is impossible to make tests which both are hard enough to extend the older cleverer subjects and also are confined to common knowledge for their materials'.[1] In his view, 'if tests could be devised and standardized which would give a fair chance to the superior intellects to show their powers of abstract thinking, they would be found to go on developing for years after sixteen'.[2]

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[1] *Instinct, Intelligence and Character*, p. 222.

It may be that Thomson is right. But he has, perhaps, little evidence that existing tests do not give 'a fair chance' to superior intellects over sixteen. He believes that their results are possibly distorted by the influence of speed. Dealing with the scores obtained by persons of different ages in the Otis Advanced Test—where, as we have seen, 130 is the average score of persons of eighteen, and is not exceeded by older people, he suggests that perhaps 130 is 'not the limit set by intelligence but by speed'.[3] This suggestion, however, is difficult to accept, because many individuals, as Thomson himself frankly admits, obtain scores over 200. The same holds good for other tests—the reason why scores fail to increase after sixteen is not that it is impossible for any one to secure higher marks. Still, Thomson's contention that intelligence continues to grow for many years after sixteen may turn out to be true. We can only say, in his own words, that 'experiment finds it impossible to demonstrate' such a growth.

At whatever age intelligence reaches its limit, there is clear evidence that growth of intelligence is more rapid at the beginning than later. During the years when the average scores in intelligence tests are rising, the annual increases become steadily less. Another discovery is that an individual's intelligence quotient tends to remain constant. Although his intelligence grows, its relation to that of his contemporaries does not appreciably change. The boy who is cleverer than another during childhood normally retains this advantage throughout the rest of his life.

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[1] Ibid., p. 223.

[2] Ibid., p. 225.

[3] Ibid., p. 222. Thomson also seems to suggest here that it must be a defect in a test to involve speed as well as accuracy. But we have already dealt with this point. See pp. 62–3.

A question of some interest and importance is whether intelligence, having reached its maximum, thereafter declines. There is a conflict of evidence. Foster and Taylor, who applied tests to 737 persons, ranging in age from ten to eighty-four, reached the conclusion that intelligence remains at its maximum level—at any rate until the onset of old age.[1] Their results indicated that older people fail, not in the capacity for relational thinking, but in the power of memorising.

On the other hand, tests applied to over 15,000 officers in the American Army revealed a continual decrease in score as the officers increased in age from twenty to sixty. These results are perhaps unreliable. The differences between the average scores of officers of different ages were small in comparison with those between the scores of individual officers of the same age; the samples of the different ages may not have been representative; and the older men may not have entered whole-heartedly into the testing.[2] Some corroborative evidence, however, was afterwards obtained from an investigation in which 823 persons, varying in age from five to ninety-five, were tested. This investigation led to the conclusion that intelligence remains constant throughout the twenties, and then begins to fall.[1] It also indicated that persons whose intelligence is initially high decline more slowly than those of normal or subnormal intelligence; for example, the boy who, in his youth, is in the top 10 per cent, would still, at the age of eighty, be more intelligent than 50 per cent of adults. But, as we have said, the evidence on the whole of this matter is at present equivocal, and judgment should be suspended.

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[1] *Journal of Applied Psychology*, Vol. IV, pp. 39–58.

[2] At any rate, the official report declares, for unstated reasons, that the continued decrease in scores 'cannot be said, on the basis of the present information, to point to a decrease of intelligence with age.' Quoted from Spearman, *The Abilities of Man*, p. 372.

INTELLIGENCE AND SEX

Intelligence tests have failed to disclose any significant differences in intelligence between the sexes. Burt did indeed find that, among nearly 3,000 London children, the girls excelled the boys at almost every age from three to fourteen.[2] 'The difference,' he says, 'swells to a maximum about the age of six or seven; at ten it is reversed in favour of the boys; but their recovery is transient; towards fourteen the superiority of the girls is again visibly mounting.' And he thinks that it supports the view that in intelligence, as in other respects, girls mature more quickly than boys. But on the whole, he does not regard the difference as significant.

Other investigators have reached the same conclusion.[3] The average scores of the sexes seem to coincide, and there is no clear evidence that the members of one sex exhibit more variation in intelligence than the members of the other.

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[1] Cf. Miles and Miles, *American Journal of Psychology*, Vol. XLIV, pp. 44–78.

[2] *Mental and Scholastic Tests*, p. 193.

[3] Cf. Terman, *The Measurement of Intelligence*, pp. 68–71, and Terman and Merrill, *Measuring Intelligence*, p. 34; and Pressey, *Journal of Applied Psychology*, Vol. II, pp. 323–40.

INTELLIGENCE AND OCCUPATION

In the First World War, as in the Second, American recruits were drawn from a great variety of occupations. Accordingly, their scores in the intelligence tests provided valuable information concerning the different degrees of intelligence found in different occupational groups. They showed, as we might have expected, that, in respect of average intelligence, the professions were at the top, and the unskilled manual occupations at the bottom. For example, the average clergyman excelled the average photographer; the average photographer excelled the average butcher; and the average butcher excelled the average labourer. The results also showed, however, that the range of scores in any one group was considerable. Although the average physician was more intelligent then the average filing clerk, some of the filing clerks were more intelligent than some of the physicians.[1]

Other inquiries have been made into this matter, and they, too, have shown that occupations can be arranged into a hierarchy according to the degree of intelligence that they demand. Burt, for example, has drawn up a provisional scheme in which the commoner occupations are divided into eight classes, and this scheme, although admittedly tentative, has been found useful as an aid to vocational guidance.[2] Of course, the degree of intelligence that any occupation requires depends not only on the nature both of the work itself and of the course of training involved, but also on the amount of competition in the occupation at any particular time. For these reasons, Burt's scheme has been found to need some modification,[3] and new lists of the different intellectual minima of different occupations have been prepared.[1]

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[1] Cf. Brigham, op. cit., p. 70.

[2] Cf. Burt, *A Study in Vocational Guidance*, pp. 4–7.

[3] Cf. Macrae, *Talents and Temperaments*, pp. 158–63.

INTELLIGENCE AND CHARACTER

Apart from the well-known temperamental traits that accompany the various types of mental deficiency, there are no doubt many other interesting relations between intelligence and character. But our knowledge of them is at present uncertain and incomplete. Nevertheless, one or two facts have been disclosed by the use of intelligence tests. Burt found, for example, that 80 per cent of delinquents are below the middle line in intelligence, and that at least 8 per cent are mentally defective, whereas the corresponding percentages in the whole population are 50 in the first case, and between 1 and 2 in the second.[2] And his conclusion that subnormal intelligence is a notable factor in the production of crime has been borne out by many other inquiries.

This connexion between crime and a low degree of intelligence is not surprising, because, where intelligence is lacking, it is impossible to establish a self-controlled and well-organized character. 'The defective child', as Burt says, 'is without the necessary insight to perceive for himself, or to hold effectively in his mind, that what tempts him is dishonest, and that dishonesty is wrong.'[3] In other words, the born simpleton falls into crime, because crime is, after all, usually just a stupid way of compassing one's ends.[1]

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[1] Cf. Oakley and Macrae, *A Handbook of Vocational Guidance*.

[2] Cf. Burt, *The Young Delinquent*, pp. 296 sqq., where the sensational statistics of some American investigators are also given. A person is regarded as mentally defective when his I.Q. is below 70.

[3] Ibid., p. 301.

Regarding other relations between intelligence and character, there is some evidence that the bright person is more willing to take the lead, more eager to break new ground, and more disposed to talk, than the person of average intelligence.[2] It also seems probable that intelligence is positively correlated with freedom from mental inertia. The highly intelligent person is active, and he can pass from one task or train of thought to another with ease and rapidity.[3]

INTELLIGENCE AND PHYSIQUE

Damage or disease of the brain has long been known to cause mental disturbance. In general paralysis, for example, where there is a gradual decay of the nervous system, the patient's mental life is reduced, towards the end, to the simple perceptions that he enjoyed as a baby. Improper functioning of the endocrine glands also affects our mental capacity. For instance, a child who suffers from an uncorrected thyroid deficiency is a person of low intelligence who can perform only the simplest tasks.

There is evidence that other physical defects impair one's intelligence. Sandwick applied an intelligence test to 423 students, and then subjected the highest 40 and the lowest 40 to an exhaustive medical examination. He found that 52 per cent of the highest 40 were free from all defects, while none of the lowest 40 was so.[4]

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[1] A high degree of intelligence is not, of course, incompatible with criminality. Satan has never been charged with lack of ability, and Goering was found to be in the top percentile in intelligence. But the researches of Burt, Healy, and others have all shown that most knaves are also fools. Cf. pp. 89–92 below.

[2] Cf. Nelson, *Personality and Intelligence*.

[3] Cf. Spearman, *The Abilities of Man*, Chap. XX.

[4] *Journal of Educational Research*, Vol. I, pp. 199–203.

But this result relates to persistent defects, not to ordinary transient illness, which seems to have little or no effect. Dawson applied intelligence tests to 1,077 children in the Royal Hospital for Sick Children in Glasgow. 'On the whole,' he says, 'it was only in cases where there was disease of the ductless glands or of the brain that there was appreciable departure from the normal in intelligence.'[1]

Studies of the correlation between intelligence and such bodily traits as height, weight, size of head, etc., have also been made. Where the results have had any significance at all, they have pointed to the existence of a positive connexion between intelligence and bodily size, at any rate among children, if not among adults.

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[1] *Intelligence and Disease*, p. 51.

CHAPTER VII

THE USES OF INTELLIGENCE TESTS

> 'The intelligence tests now in use have proved of the greatest value in actual practice.'—C. S. MYERS: *Industrial Psychology in Great Britain.*

WE have now dealt with the essential nature of intelligence, with the manner in which intelligence tests are constructed and standardized, and with the main facts about intelligence that the use of tests has revealed. We conclude by considering the practical purposes for which intelligence tests are being profitably employed.

THE DIAGNOSIS OF MENTAL DEFICIENCY

Intelligence tests are widely used by psychologists and school medical officers in the diagnosis of mental deficiency. Individual tests are usually chosen, and, among these, the Terman-Merrill New Stanford Revision of the Binet-Simon Scale is now becoming the most popular in Britain as well as in the United States.

Obviously, in examining suspected cases of mental deficiency, standardized psychological tests are much better than unstandardized questionnaires and problems made up by persons with no psychological or statistical training. Idiots, imbeciles, and lower-grade mental defectives in general, can probably be detected by the crude, rule-of-thumb methods that used to be common. But to rely on such methods to determine whether a person shall be ranked as a mental defective or as a border-line case is like using a home-made and inaccurate yard-stick for measurements that require a micrometer.

In the diagnosis of mental deficiency, as in other connexions, intelligence tests can give much valuable information about the individual besides a measure of his intelligence, for we can observe not only his total score, but also his performance in the various types of problem of which the test is composed. We can notice, too, the precise nature of his wrong answers—whether they are absurd or merely inaccurate, and whether they exhibit those automatic repetitions that are a frequent symptom of deficiency.

THE GRADING OF PUPILS

Intelligence tests are being increasingly used to classify pupils. In many schools the children are tentatively graded by means of intelligence tests as soon as they enter. Three grades are usually employed; there is a 'bright' group, a 'medium' group, and a 'dull' group, and they are given respectively an enriched course of study, the regular course, and a simplified course. Although these classifications are always regarded as merely provisional, and a pupil may be moved from one group to another, it is found that in practice very little movement is necessary.

The value of this application of intelligence tests is, of course, that it secures classes that are homogeneous in general ability; it brings together those who should be together. Of course, care must be taken to ensure that the pupils in any class are approximately equal in age as well as intelligence, because harm may result if dull older pupils are put with bright young pupils. Where it is possible, the best plan is first to divide the pupils into groups according to their intelligence, and then to subdivide these groups according to age.[1]

Under the usual system, by which pupils often tend to be grouped merely by age without regard to intelligence, it is customary to find wide differences of intelligence in the same class. This usually has the result that the pace of the class is the pace of its weakest members—that the bright pupils are held back by the duffers, and placed in danger of developing slow and slothful habits of work. The boy that can quickly assimilate what he is taught has to sit patiently while the topic is repeated and amplified and elucidated for the slow-coaches. He therefore works at low pressure, and—what is worse—may become accustomed to do so.

Moreover, if a class of unequal ability is bad for the bright pupil, it is also bad for the dull one, because, in the long run, no one is helped by being pitted against people with whose ability his own cannot really compare. If a person is always straining, or being driven, to do something that lies beyond the reach of his powers, he becomes confused and despondent. No doubt healthy rivalry is a valuable stimulus even for the dullest among us. But there is much to be said against requiring people to attain the impossible. Consequently, when school pupils are graded according to their ability, the dull as well as the bright are being sensibly treated.

Still, it is the bright pupils that benefit most when classes are arranged to secure approximate equality of intelligence as well as of age. Investigation has shown that, where there is no grading by ability, clever children are more often retarded—in lower classes than their intelligence warrants—than dullards. This is because they get through their work without causing the teacher any concern, and so tend to be overlooked.

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[1] In small country schools this plan naturally cannot be put into effect. Nevertheless, even in these schools the pupils' intelligence should be assessed, so that their school-work and home-work can be made appropriate to their capacity.

It must be remembered that, if we wish to subdivide an unselected group of adults, or of children of the same age, into three or more approximately homogeneous sub-groups, these sub-groups cannot be equal in size. This follows from the fact that, since intelligence is distributed in accordance with the normal curve, the number of individuals in the middle range is much greater than the number at either extreme. Among Thomson's 2,710 children, for example, 1,240 had I.Q.'s between 90 and 110. Usually when children are subdivided into approximately homogeneous groups, 20–25 per cent are placed in the 'slow-moving' group, 50–60 per cent in the middle group, and 20–25 per cent in the 'fast-moving' group.

Intelligence tests can also play a valuable part in examinations for entrance to secondary schools. When such examinations are composed solely of tests of attainment, boys and girls that lack the ability required for secondary education are sometimes propelled into secondary schools by high-pressure coaching and cramming, and their subsequent school-life is a burden to themselves and their teachers. The value of intelligence tests in this connexion has long been recognized by the Ministry of Education, which many years ago made them the subject of a special report. For their historical interest, and because they remain apt and authoritative, two paragraphs of this report may be quoted:

> 'The Bradford Education Authority in 1919 adopted, for the purpose of junior scholarship examinations, a number of the written group tests first used in 1911 for an early research at Liverpool. Two years later, at the request of the Northumberland Education Authority, Professor Godfrey Thomson devised a set of group tests for much the

same object in what was one of the most notable experiments on the subject in this country. It had been observed that nearly one-third of the schools in the county of Northumberland presented no candidates for the ordinary scholarship examinations in English and Mathematics. These schools were largely small schools in isolated rural districts, such as the Cheviots and the Dales; and it appeared possible that, from lack of home culture, of town life, and of teaching facilities, many of the best county pupils might be handicapped in essay-writing and arithmetic. Three thousand children were accordingly tested; and it was found that many of the most successful pupils resided in the remoter areas of the county. This early experiment was so successful[1] that a group-test of intelligence has since been introduced on every occasion into the Northumberland examinations for such scholarships.

'Similar difficulties have been encountered by other English education authorities; and have been dealt with experimentally by similar means. Dr. Ikin, Education Officer for Blackpool, has tested a group of one hundred scholarship candidates for Junior County Scholarships with five of the better-known groups tests (the Terman, Otis, Northumberland, Simplex, and National Scale respectively). At Rugby, Mr. Vaughan has applied a set of group tests, devised in London, first to certain selected forms and later to the whole of his school. At Cheltenham Grammar School, Mr. Dodson has applied the same tests (with others) both to the entire school and to candidates for scholarship and entrance. These are but a few of the more notable experiments upon these lines.

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[1] Of twenty pupils selected solely on the ground of intelligence tests, nine took first place in their respective classes in secondary schools, and eleven took second or third places.

Where the results have been statistically analysed, it is found that the calculated correlations show a close correspondence with the results of independent scholarship examinations or of independent personal judgments. Where the tests and the scholarship examinations disagree, subsequent study of the children shows that the test has often revealed inborn ability which the scholastic examinations failed to detect, owing to the child's lack of opportunity, at school or at home, for acquiring the necessary knowledge. None of the investigators, however, has as yet claimed that intelligence tests can do more than supplement written examinations of the ordinary scholastic type. Before a child can be admitted to a Secondary School he must possess a certain minimum of educational knowledge; and this is to be gauged, not by a test of mental capacity, but by a test of scholastic acquirements.'[1]

Intelligence tests have also been used in connexion with examinations for entrance into universities and training colleges. Columbia College and Columbia University and the London Day Training College for Teachers provide two examples. In the former a test devised by Thorndike is employed, and valuable data concerning its usefulness have been collected. Reporting on this evidence the Dean of the College says: 'Since the introduction of the Thorndike Test the percentage of men who are forced out on account of poor scholarship has been cut in half, although our scholarship requirements have been lifted during the interval.'[2]

British universities would be improved by the use of similar tests. Those of us who are responsible for psychology in universities have all been consulted by harassed undergraduates who have scraped through the entrance examination—perhaps at the fourth or fifth attempt—but cannot cope with university studies. And we know how often a test reveals that their intelligence is altogether inadequate to university work. Macrae gives an interesting example of the benefit that could be derived from insisting that intending university students should produce evidence of ability as well as acquirements: 'A girl whose school career had been undistinguished, succeeded, after several fruitless attempts, in satisfying the entrance regulations of an Irish university. Her father was a member of a learned profession, and it had not occurred to him as possible that his own gifts had not been inherited by his daughter. True the girl was backward in her studies, but backwardness may be due to many things other than lack of capacity; for example, it may be the result of inefficient teaching. It was only after two completely unsuccessful years spent at the university that it was decided to abandon the unequal struggle and to seek vocational guidance. The intelligence test showed that the girl's percentile rank, among girls of secondary school education, was below 10. If the test had been applied some years previously, a great deal of unhappiness and misdirected effort might have been prevented.'[1]

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[1] *Psychological Tests of Educable Capacity*, pp. 37–9.

[2] *Columbia Alumni News*, Vol. XV, p. 390, quoted by Thomson, *Instinct, Intelligence and Character*, p. 192.

CHILD GUIDANCE

Child guidance is another activity in which intelligence tests are of value. Clinics, designed to assist children exhibiting psychological difficulties that neither time nor the ordinary methods of correction can remove have been established in many cities; for example, in

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[1] *Talents and Temperaments*, p. 46.

London, Manchester, Edinburgh, Glasgow, and Aberdeen in Great Britain. They deal, not with mental defectives, but with 'problem' children at any distance above the border-line. Frequently, of course, the cause of a child's unsatisfactory mental development or behaviour does not lie in his intellect, but in his physical condition, his temperament, or his environment at home or at school. Accordingly, all these matters must be investigated. Nevertheless, our own experience in Aberdeen has confirmed the fact that in every case the child's intelligence must also be examined. 'A lack of intelligence', as Burt has said, 'may be the main reason for his faults, or the possession of intelligence the sole hope of reform.'[1]

Some children are reported to be 'generally backward', or 'poor at reading and counting'. Often when we apply an intelligence test we find that the condition is due merely to lack of intelligence, not to any fault of the teacher or parents, not to laziness or timidity on the part of the child. On other occasions, however, the use of an intelligence test shows that the child's backwardness is not due to dullness; and this negative information is also of importance in that it directs our inquiries to the other conditions among which the cause must be found.

Sometimes subnormal intelligence reveals itself in misbehaviour as well as in poor scholastic achievement. We have already pointed out that a modicum of intelligence is a necessary, although by no means a sufficient, condition of normal moral development, and we have referred to Burt's finding that 80 per cent of juvenile delinquents are below average in intelligence. But, even in a person who is not actually delinquent, dullness can produce unfortunate effects. And sometimes these are due more to his awareness of his dullness than to the dullness itself.[1] One of our cases in the Aberdeen clinic has been that of a boy, aged nine, who was brought because he regularly bullied his classmates during the morning and midday recesses. The trouble with this boy was that he was dull and that his dullness had placed him in a class with children two or three years younger than himself. Naturally, he was aware of this unflattering difference in age, and he resented it. Hence in the playground he employed his greater size and strength in attacks on his classmates—attacks that were prompted by a desire to redress the balance.

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[1] Cf. Burt, *The Young Delinquent*, Chap. VIII, where many illustrative cases are given.

The cause of some other children's difficulties is a mistaken belief that their intelligence is inferior—a belief that inhibits their activities and may become an obsession. With such children, the application of an intelligence test, which shows that their capacity is not really below average, often proves of the greatest value both in helping to remove their lack of self-confidence, and in preventing them from being unjustifiably dubbed as dunces or loafers.

In still other cases, the use of intelligence tests discloses that psychological difficulties sometimes arise in persons possessing a high degree of intelligence. At school, clever children may indulge in horseplay and 'teacher-baiting', because the work of the class is too easy for them. Outside school, they may be led into undesirable activities because their occupation or their home provides no outlet for their ability.

In this matter, however, our experience agrees with the greater experience of Burt. 'In the young,' he says, 'great ability is never of itself the sole cause of crime. Not once have I found occasion to enter superior cleverness under the rubric of a major factor. Where it comes into play as a secondary cause, the real trouble flows usually from some adverse situation which the child's intelligence only in part assists to create—from a disparity between the sharpness of the child and the dullness of his parents, or between the child's high capacity and his low class in school, or between his far-reaching ambitions and his narrow and monotonous vocation, or between his own cramping poverty and the comparative wealth of the associates amidst whom his high talents have thrust him. Generally, too, there is some added temperamental factor—some powerful instinct, some inner emotional upheaval—which precipitates the final outbreak. For the rest, a quick intelligence inspires the method rather than the motive of the crime.'[1]

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[1] Speaking of such children, Burt says: The dim half-realized sense of their born inferiority, an inferiority which they cannot help, but for which they are incessantly blamed, may act as a rankling grudge against the world in general. Or against their luckier relatives and school-mates.' (Op. cit., p. 243).

VOCATIONAL GUIDANCE AND SELECTION

Intelligence tests are also employed in vocational guidance and selection. When vocational guidance is given to an individual, he is examined mentally and physically, and advised as to the occupations for which he is fitted and unfitted. Obviously, it is important in this connexion to know the degree of his intelligence. Intelligence, of course, is not the only quality of vocational significance; physique, character, knowledge, and special abilities also affect an individual's success, and must be taken into consideration. Nor is intelligence always the factor that most influences success. At least one public school man has earned a four-figure salary in sales organization, although his percentile rank in an intelligence test was below 10.[2] Still,

[1] Op. cit., p. 355.

[2] Cf. Macrae, op. cit., p. 162.

intelligence, as we saw, enters into all forms of work, even those where it does not play a prominent part, and it is desirable that an individual should possess intelligence of the same order as that required by his work. If he has too little intelligence, he will be incompetent and in danger of developing a distressing sense of inferiority; if he has too much, he will feel himself thwarted.

Here again it is worth while to quote a case from Macrae, who has had exceptional experience in vocational guidance and believes that to the vocational adviser the intelligence test is an invaluable aid. 'A boy who had succeeded in matriculating, but who had not been regarded as possessing any outstanding ability, was placed in an occupation which demands only modest capacities and which does not normally lead to work of a more exacting kind. He was vaguely discontented with his work, and after a few years his temperamental condition became somewhat abnormal. His father brought him to a psychologist, not for vocational guidance, but for advice as to whether any form of psychological treatment might induce a more cheerful outlook on life. The boy's performance in the intelligence test was a brilliant one; his score compared favourably with the scores usually obtained by highly distinguished graduates engaged in university teaching. The psychologist said that a much more stimulating vocational objective was desirable, and that probably this would prove a sufficient cure. The advice was followed, and the boy, when last heard of, was studying for a degree at Cambridge, where he appeared to be not only successful, but also entirely happy.'[1]

Vocational selection is the technique by which mental and physical tests are employed to select the most suitable applicant for a vacancy. Here, too, intelligence tests are required, especially in connexion with occupations where a high degree of intelligence is an indispensable qualification. Many firms are now using such tests as part of their procedure in selecting new employees, and the same practice has been adopted by the Civil Service. As early as 1926, for example, nearly 40,000 candidates for clerical posts in the Civil Service had already undergone an intelligence test as part of the competitive examination, and an analysis of the published mark-lists showed that the test correlated more closely with the candidate's general performance than any other paper.

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[1] Op. cit., pp. 45–6.

Since then the Civil Service Commission has introduced intelligence tests into its selection procedures for many other classes of Civil Servants, including the Administrative Class in the Home Civil Service and the Senior Branch of the Foreign Service.

But perhaps the most striking evidence of the value of intelligence tests in vocational guidance and selection was afforded by their use in the Forces of the principal nations in the Second World War. In the Forces of the Axis no less than in those of the Allies they formed an integral part of the sifting procedure whereby millions of men and women were allocated to suitable military duties.

CONCLUSION

Intelligence tests, then, have many uses. They are of proved practical value in the diagnosis of mental deficiency, in the grading of pupils, in the clinical study of 'problem' children, and in vocational guidance and selection. Wherever it is important that an individual's general mental capacity should be assessed, an intelligence test, scientifically constructed and standardized, should be employed.

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